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The Pyschological and Pedagogical Basis of General Science

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Ever since the dawn of history there have been fads and styles in everything. Education has had its share. There have been certain types of education which were only fads, perpetrated upon suffering humanity because they were longing for a solution to the educational problems. There have been certain types of education which have been stylish and to this might be added tradition which has been a great drawback to progress in education. The subject of general science came into existence a good many years ago, so far back that no definite record is known. It met with a certain amount of response in the form of natural philosophy a few generations ago, then slowly died out as college influence worked its way into the secondary educational institution. College professors dictated what these courses should be, rergardless of the welfare of the community or of the pupil. The psychology of the secondary pupil was not then well known, and I mean by that, the psychology of interest, appreciation and selectiveness, a thing which will be discussed a little later.

It has often been asked, why there is such a difference between the graded school and the high school. At no time in a pupil's life is there such a radical change as that which takes place from the graded school to the high school. One school dominated by trained teachers, equipped in every way with the theory of pedagogy and with an understanding of the psychology of young people, and the other dominated by teachers who have worked under college professors, lacking in the theory of pedagogy and totally misunderstanding the psychology of the young pupil. In the graded school more individuality is shown, better response on the part of the pupil is given, because the teacher has the interest of the child

[1] Address presented at the Chicago meeting of the Central Association of Science and Mathematics Teachers, November, 1918.

at heart and not the interest of any individual subject. This is the age of children in the graded school. The child is studied and better understood today than at any time in the history of education.

Our textbooks are also improving slowly. Have you ever written something which a child would enjoy to read? Have you ever published a textbook which a boy or girl would pick up and study for the mere pleasure of it? Those are the problems which are confronting the school interests today. Not only are the majority of textbooks wholly inadequate and unsuitable to the student, but they are written in an abstract way which are studied only for the sake of passing certain examinations and the standards which is maintained is merely a standard of passing examination. The vital subjects of interest, appreciation and selectiveness are almost, if not totally, neglected in the average textbook of today. It is not the matter of what the child comes in contact with that the text writer interests himself, it is merely a certain line of reasoning and a certain amount of information he thinks a child ought to know. You hardly ever attend a meeting but what you hear that trite, worn out, threadbare statement, "What a child ought to know." It is not the question of what a child ought to know, but what a child could learn that will be useful to him, now, during the present day, this week; not what he ought to know for the future, but the things which are necessary for him to know to solve the problems he meets before he goes to sleep today, and that is exactly what you and I do when we do anything after we are grown up. The high school curriculum has been dominated and the teachers have been bullied into the idea that they must teach certain formula and certain facts regardless of the interests of the school, the pupil or the community, to satisfy a supreme dogmatic demand of the college professor. He has sent many of his pupils into the schools to teach and they teach under his philosophy and they will continue to do so until educational interests demand that the welfare of the school, the student and the community must be placed before any college entrance examination. Why is it one teacher is liked by the pupils? Why is it that certain pupils enjoy the subject taught by the one teacher in the school, while another may be teaching the same subject and all the pupils under him dislike, not only the subject, but the teacher. Is it the personality alone that is counting? I say "No." It is the presentation of the subject matter, one teacher is presenting it from a vital standpoint to the students, the other is teaching it merely for the

subject and the subject matter, and there is a wide difference in such teachers. I would not have one of the latter in my school if I could help myself. In the grades the teacher has the interest and the training of the child at heart, in the high school the majority of teachers have the subject matter at heart.

The subject of general science again became foremost in the attention of educators a few years ago. Some condemned it as a fad, others subjected it to the criticism of being stylish, while others believed it to be merely a subject for preparing students to take up the more serious study of science. As time went by and teachers became more acquainted with the field of general science, the more they were convinced that it was a subject necessary for vitalizing, socializing and visualizing the every day experiences of our boys' and girls' lives. The revival of general science is an out-growth of a general rebellion against formular physics, chemistry, etc.

I once heard a prominent scientist teacher say, "I well remember my own first experience in a laboratory. I had heard a good course of lectures on the subject and was looking forward with eagerness to the laboratory work. When I entered the laboratory, the instructor handed me a pin and told me to determine whether the cross section of the pin was true or not. When I asked him what use there was in doing that, he explained that the scientist was much more interested in the minutest irregularities which he could by hook or crook discover, than he was in the operation of the machinist, whose function was solely to make machines that would go and do things. It took me about five minutes to satisfy myself that the pin was round, so round that its usefulness as a pin could not be discounted. The rest of this period was spent in trying to bend the pin with the help of the calipers into a shape that it would stand on the table point up and while the student nearest me was away, I surreptitiously placed it on the seat of the stool next to mine, and thus tested its efficiency as a pin, when the young fellow came back and sat on it."

The boy is full of energy and curiosity which can only be utilized by appealing to his curiosity, which in turn reacted upon his motor activity, producing results which are not only comprehensive to the boy, but results in holding his interest as well as producing a spirit of work which is a pleasure for the boy to accomplish. I do not, however, wish to imply that any course or study should appeal to any boy because it is soft and easy going, nor should a course be made uninteresting and hard to make the boy

work. The only object is to get his interest and to hold it because of obtaining definite results. The results of which will be either interesting or useful to him. That is exactly why the most of us do anything original or vital. We expect results. The usual expectation from the student of science is that he asks and receives a good mark, or gets his note book O. K., or receive a blue check on an experiment.

As the world is full of vital, useful and interesting things, all science may be made vital, useful and interesting. Any one thing in science may out of necessity be all three. There are some things which are vital. There are some things which are necessary to know and there are some things which are interesting to know. Now in our life in a day's time, we do things out of necessity. We do certain things because they are vital and we enjoy some things because they are interesting and we learn other things because they are useful. Upon these three great issues one directs most of his energy. With the world in which we live full of vital, useful and interesting things, it is a surprising and sad thing that many of the people and especially teachers go through this world and die without seeing the beautiful and interesting things we find about us. It takes very little effort on the part of any teacher to open the eyes of his pupils to the things which will function throughout the pupil's entire life. How often have I heard an old person say, "When I was a boy we had a book 'Natural Philosophy.' This book was a store house of information. It was an introduction to the science of interesting every day things. As a result of the study or reading this book, many of us began to understand the world about us. In the years as I grew older, I always regarded that natural philosophy as most valuable." A distinguished physicist of an American university has said that such books did more to interest the people in the world about them, than any subsequent books. A surprising fact and one which is lamentable, is that too many of us as teachers in scientific subjects, go through the world with a pair of scientific spectacles which have been stained the color of abstract facts, in order to filter out the rays of the beautiful, interesting and the vital science facts of the world that surrounds us.

Now with these two points in mind; that the student is interested in the subject of science and that the world is full of interesting subjects, let us analyse them in a common sense way and see what they mean. First, I have said all boys and girls are willing to be-

come interested in science. If they find something interesting and worthwhile, the world is full of interesting and worthwhile things. Let us see if there is a way to bring them together.

Teachers are too likely to use a strictly scientific language, which is too scientific and too indefinite for the boy or girl to understand. Many an amusing incident happens which shows that a student does not understand. In a test that I made recently before a class for my own satisfaction, I found a lack of ability to tell exactly what was meant when students tried to express themselves in some scientific terms. Three questions were asked. What is a molecule? What does it look like? Have you seen one? The class consisted of over two hundred pupils who were entering a normal school. They were all graduates of a high school and entered with physics and chemistry as a prerequisite. In most cases the answers were interesting. A number explained a molecule as a small round thing in things. Undoubtedly this answer would have surprised the teachers who taught those pupils the meaning of molecules. One young lady insisted that she had seen one. Several said that their teachers had seen them. Many teachers would be astounded or mortified at the answers if they were to ask their pupils practical questions on this subject.

Not long ago I asked some pupils who had gone down in an elevator, what caused the funny feeling in their stomachs when the elevator dropped suddenly, and they looked at me with peculiar expressions in their eyes, because I had asked such a question, and one laughingly said, "I don't know." I then said, "Have you ever studied physics?" "Yes, last year." "Can you not apply some principle of physics to this thing?" He said, "I have not thought of it before." And truly he had never thought of this before.

One day while walking on the sidewalk a girl stubbed her toe. She ran a few steps, turned around and smiled, as she nearly fell down. She happened to be a pupil in the school where I was teaching. I asked her if she knew why she ran when she stubbed her toe. She smiled and said, "So I wouldn't fall down." I replied, "To be sure, but why would you have fallen down if you had not run a few steps?" She said "I don't know." A few days later she came to my class room and said "I have an answer to your question." I had forgotten the incident so she recalled it to me and this was the way she explained it. "When I stubbed my toe, my feet stopped, my head kept on going, therefore I had to run to catch up with my

head." Exactly so, she had explained it in a common sense way.

Recently on a teacher's examination paper the question was asked, "How is coal made to leave a shovel when trying to throw it on a fire?" The young lady taking this examination had done very well on her abstract questions, which dealt with the physics, but this is the way she answered the question regarding the coal. "After getting the coal on the shovel you hold it at the furnace door, the flames jump up and lick it in." I have given you these examples all from experience, and may I say that the pupils in all cases did know what inertia was, but it would have been hard work to have associated inertia with something that had actually happened in their every day experiences.

Examine a teacher who has had physics, chemistry, biology or any other science in school, who are not teachers of these subjects, and ask them a few simple questions about simple phenomenon and they will be unable to explain. They have had physics. "Oh yes. When I was in college, or when I was in high school, but I have forgotten it all." You might say that was the same of Latin. We had that in college and high school, but that is a dead language. It no longer lives among us. Ninety-nine per cent. of the problems of our lives are surrounded by science activities and they are not abstract problems either. The trouble is that some of us as teachers are dead. We died long ago. We have been buried under six feet of abstract facts and formulas. We had a funeral service on note book computations, etc. The flowers and the beauty of real living things were not present and we have stayed dead and nothing will resurrect us until we have thrown aside all of this material, which is good-for-nothing, useless material to the average pupil, and re-organize it around the beautiful, the living and the active world. And that note book, the marvel of all wonders, with the objects, apparatus and the observations. What you have seen; what you ought to have seen; what you did see; what your teacher wanted you to see and usually a scene after school, the latter, if you are not a good mind reader and have not clearly read the mind of the teacher, and were not able to find out just what was expected of you. Some one will say, you are not a science teacher, then I thank God I am not, and I don't want to be, if science cannot consist of the real, live material and the problems which you have at hand to be solved from day to day. In other words we must talk to pupils, we must teach pupils, and we must learn with pupils in the language they know and in the environment they understand.

There is another valuable psychological reaction which has been talked about a great deal but has never been practiced and that is to make pupils observe. Ninety-nine per cent. of the science teachers do not teach pupils to see things and it is only one teacher out of a hundred we find acting upon the principles of psychology to produce observation.

It has long been a practice of mine in the class room to spend ten minutes of the period in answering questions or discussing observations of the pupil. These ten minutes I presume have been most interesting. I have allowed each pupil to ask one question, or to give one observation. Throughout the year I kept account of the questions asked by pupils about things which they had seen. The number amounted to 1056. In succeeding years I tried to keep account of the number of times the same question was asked by different pupils. Sometimes it was as many as ten and other times it amounted to many more. This shows that pupils see the same interesting things, from day to day. The teacher should be willing to spend a little time in trying to open the eyes of his students to the art of observing things. Such incidents as this have been reported. One girl said, "Last night while washing dishes, one glass stuck tightly into the other and I was unable to remove it, until I had placed them in hot water. I asked my mother why this was so and she did not know. She had not thought of it."

Another incident by another pupil. "In our room we have a fireplace. Last night we put some wood on the fire and a short time afterwards a piece of the wood had blown almost into the middle of the room. I tried to explain it, but I could not find any reason." This question was answered by one of the other members of the class. Such questions as these are coming up daily in the experience of everyone.

As soon as pupils begin to realize that they can see and understand some of the things about them, they begin to react. A short time ago one of my pupils coming across the meadows observed the fact that the fog stood about three feet above land. She wanted to know why. She had crossed the meadow hundreds of times before entering the science class and never wondered at this phenomenon.

Another asked, why ice steams on a hot day? I was rather amused at the answer of one of the pupils who had had considerable science. "Because the ice was evaporating and you could see it go," was his answer.

Truly we can teach vital problems in a vital way. We can also teach the students to observe if we only get away from the habit of trying to drill a few definite laws into their minds to be remembered long enough to take an examination and to create within him a natural dislike for the world's scientific facts. You should not be surprised to find the boy in a physical laboratory reading Popular Science Monthly instead of doing a useless experiment.

I once knew of a teacher who had given an experiment to a boy to do with a motor. He had careful instructions laid before him and he was supposed to follow them. About one-half of the period gone, the teacher stopped at his desk to see what he had done. He found that he had not written anything about the motor, but was busily engaged, and the teacher rather sharply remarked, "Why have you not started your experiment?" The boy jumped because he had been absorbed in examining the motor and said, "I have found out how the thing goes one way, but I cannot find out how it goes the other way." If the teacher had the sense of humor and the knowledge of psychology of a boy, he would have said, "Keep at it until you do find out," but instead he dismissed the boy from the class and gave the remaining number of the class a lecture on following instructions. "Never mind what you want to know, just do as I tell you. You will learn something that way. If you want to find out anything else, do not find it out here." Rather poor psychology and I doubt whether any pupil in that class will remember that teacher as being one who influenced his life.

Students can easily be taught to observe and become interested in anything if they are allowed to discuss things about them. How often have I heard a pupil say, "I have seen more things this year going to and from school, than I have ever seen in my life before." "I notice the clouds every morning, I have tried to predict the weather. I notice the people in the car. New things, new experiences happen to me and I try to explain them." This is the spirit of observation. Not only have I had pupils come to me during class hours, but often have students come after school to ask a question which they could not answer about some phenomenon they had seen. Why? Because they are interested and because science is a thing which produces the spirit of investigation even on the dullest mind. Pupils have written letters after graduation asking for explanation of certain things which they have seen. They will never lose their interest in science.

The chief reason to my mind for the study of any general science in school is to give a consumer knowledge. We are all consumers, as well as producers, but as a consumer we must know something about food, its value in a human body, food which is costly, as far as food values are concerned and foods which are cheap, but useful. Every man should have some knowledge about his clothing, he should be able to be a judge and be a fair judge, not an expert, when he is buying a piece of clothing, to know whether he is getting the best value. He should have an intellectual viewpoint regarding his home, ventilation, the building material, the heating system, the water supply, etc. He need not be an expert, but a little knowledge will give him an opportunity to have an insight into economical values and to give him a basis for forming good judgments. If he travels he should have some knowledge regarding the best methods in travelling, Safety First, and general conditions which will keep him healthy and strong. His medicine is a vital problem when he is ill, or has sickness in his home. He should be well aware as to what are the ordinary advertisements which claim to affect many cures and produce none. He should have an intelligent viewpoint when a physician enters his home and enough scientific knowledge to carry out and understand the reason for the directions which a doctor may give. All such material is included in the practical science of every day life.

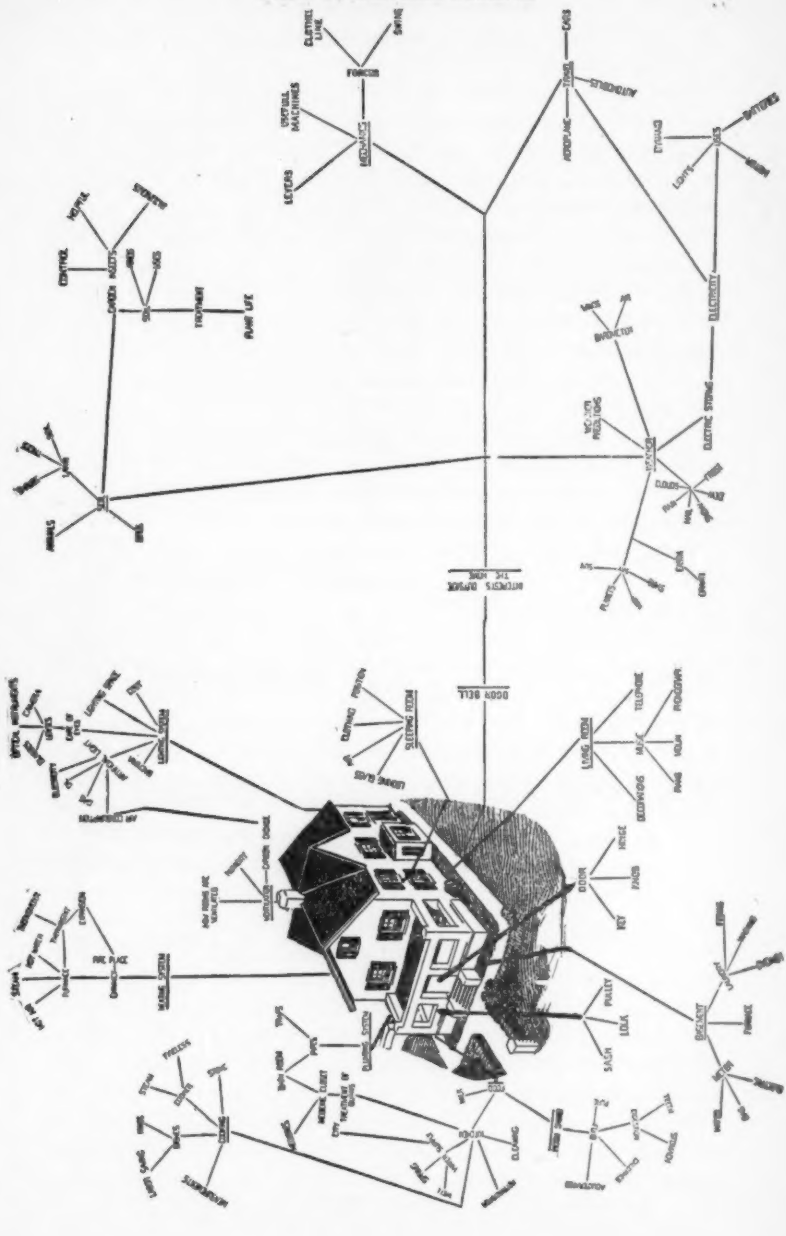
The subject matter of general science has been a field for investigation and thought. It has been exploited; the child has been exploited; and the teachers have been exploited. I have definitely made up my mind that in general science, physics should not be taught as physics, chemistry as chemistry, biology as biology, and astronomy as astronomy. Some of us have tried to make general science a sort of biology. Others, elementary physics. A few have stuck to chemistry. Others have emphasized astronomy, still others agriculture, but science must be divided into two classes, *pure* and *applied* science. In the pure science we have physics, chemistry, biology and astronomy, etc. In applied science we have agriculture and physiology. These two subjects are taught in a practical and sensible way and they do not need to be re-taught in part in general science, but out of the pure science should be selected such material as can be applied to the every day life. There are certain applications of physics, chemistry, biology and astronomy which are inter-

esting, helpful and useful in every day life. Some have tried to crowd in agriculture on top of this and made a botch of the whole thing without recognizing the fact that agriculture was a practical subject to start with and always will be taught in our schools as a practical subject. What students need to know is more of the every day environment of science which they would not get from the formal study of the pure science.

What to teach:—There are many who would say that what you propose is hard to teach. Just so. It does take time, thought, study and an abundance of energy because you must be a real live wire. No semi-dead teacher has any chance in a class room full of live, hungry and willing learners.

What to teach becomes a problem. One thing is certain. Definitions and dry scientific facts are not to be taught first without any foundation. An example of this is found in a science class when an instructor attempts to teach inertia. The definition for inertia is "Everybody continues in a state of rest or of uniform motion in a straight line, unless compelled by some external force to change that state." The student is lost before he gets through the definition. It means little to him. He sees no relation between this and his own environment and to tell the truth he has learned little. Suppose he had been asked why one must be careful to wait until the car stops before getting off? This is something he knows about. Why should one get off always facing the direction the car is going? Suppose the teacher arranged chairs in the class room and had a demonstration of mounting and dismounting a car with books in one hand. What is the result? Every one is ready to take part. Some one shows how one should get off the car. Another immediately says that is wrong. Why? If the car is moving and you get off with your back in the direction the car is going, what happens? Why? What happens when a car starts and you are standing in it? Why? We have got to call this something. What? Inertia. What does inertia make you do? What does it make everything do? What is inertia? What way does it make things go if they are moving? Tell all about inertia, etc. Hundreds of examples can be given from the spilling of soup by pushing the plate to why the world keeps on turning.

If I should ask any one of you to tell me how the water runs out of a wash bowl, what would you say? Does it run from right to left, or left to right? Does it always run in the same direction? Why does

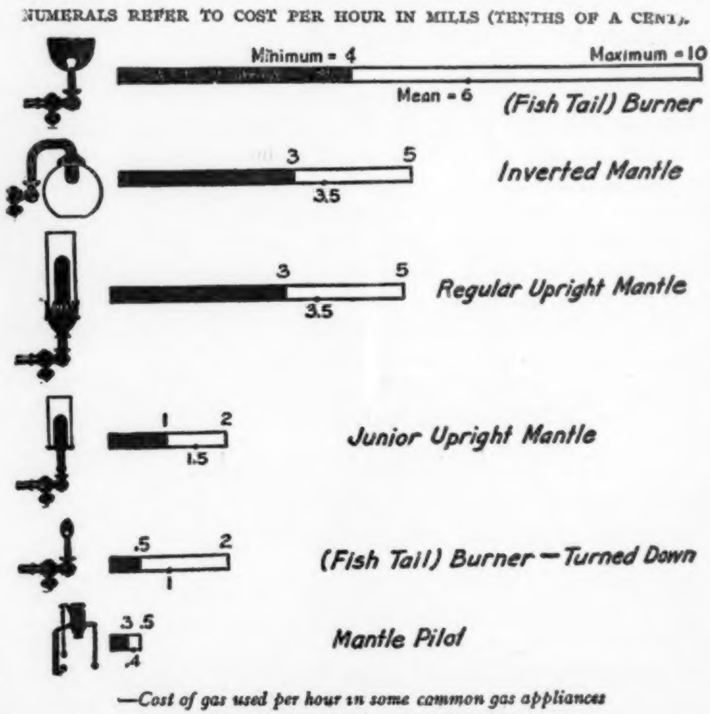


it assume a turning motion as it runs out? Do you know? Why don't you know? The phenomenon happens every day of your life.

An organization of the subject matter for general science I found to be a very difficult thing and the more I studied the proposition, the harder it became, as I was unable to definitely fix the field in which the student need to apply himself for a thorough course in the subject. I had to recognize at the start that general science meant a practical application of all the sciences and that any subject must be taught as a subject from the biological, physiological, chemical, astronomical, physical and geological standpoint. Some subjects would have more of the divisions in science, others would have less. In an attempt to organize this thing around some vital center, I drew the house represented in the diagram, and about that home as the center of all activities, I drew lines to designate the subject matter which would come into the experiences of a boy or girl. I found that this would not cover the field. That there were outside interests, especially those interests which function in the lives of pupils going to and from school.

The diagram simply shows the subject matter which is important for him to know. The subject matter is not to be taught as pure scientific facts, but to be taught as science as a part of his existence. There must be some starting point and my method was to start with humidity as the boy and girl are usually starting the subject of science at a time when moisture in the atmosphere is very vital. We have learned a great deal in the last few years about the amount of heat required in a home, and we have found that when the humidity is correct, a less amount of coal is required to maintain a comfortably heated home, in fact experts have estimated it to be from one-eighth to one-quarter less coal during the season. Now in order to make the work plain and systematic, I started with evaporation and the effects of evaporation. Each subject is to be taught from the standpoint of all science and only that part of the science which is of vital use for the boy or girl to know, therefore the physics, chemistry, biology, metallurgy, astronomy and physiology of any particular subject, no matter what it is, should be discussed for the subject in view at the time. The student easily sees the relation of the subject to all standpoints of life without studying the subject under different heads, in fact the use of general science is to annihilate the divisions which have grown up between the different groups of sciences. I do not believe there has come into our system a more vital subject than the subject of general science, which can

pick out vital facts of all the sciences and make them worthwhile to the student. Some have argued that general science should be taught simply to prepare students to take up the serious study of other subjects in science, but general science is a serious study of itself. It may or may not prepare students for future study in a more scientific manner. It is bound, however, to assist the boy in any future subject of science, even though the ultimate aim is only to give him a better understanding of his environment, and that after all is the ultimate aim of the teaching of general science. Naturally as soon as we start any subject there must be an organization or plan in which one factor fits into another, and that plan seems to start with the moisture getting into the atmosphere, effects of the moisture in the atmosphere, the moisture coming out of the atmosphere and under those three groups, we would naturally have humidity, the effects of humidity, evaporation, the effects of evapo-



—Cost of gas used per hour in some common gas appliances
(Courtesy Hinds, Hayden and Eldredge, Inc.)

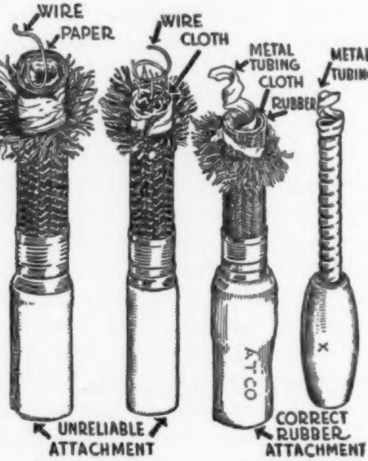
ration and this takes us into discussion of the use of many things about the home. It takes us into physiology. It discusses the humidity of our sleeping rooms. It takes us into the pantry where the butter is kept. It takes us to the shore where we go in bathing. It takes us to the sickroom. It tells about the iceless refrigerator, therefore the subject can only be taught from all the standpoints of science. The moment that the discussion of moisture comes out of the atmosphere, it is taking up weather, weather predictions, clouds and other things related to the subject of weather. This leads us to the study of the barometer, wind, air pressure and finally to ventilation. Under the pressure of air many examples may be found as practical applications. Non-skid tires being a very common example today.

Thus it is easy to see the lesson may have the physics, chemistry, physiology, etc., of the topic, combined in an understandable way as a whole, without the student realizing that many divisions of science have entered into the work.

Air pressure leads us to discuss boiling point. The subject of heat follows. How our homes are heated. Uses of heat, cooking utensils, saving of heat. Study of our heating systems. Lessons on fuel. Value of different fuels, types of burners, wasteful and saving form of burners. Here is an illustration showing how the Bureau of Standards at Washington has worked out the relations between fuel and different burners for lighting purposes. This is really vital and the student knows it without being told. He sees an immediate use for the lesson. I wanted a good lesson for students who were using gas pipes at home. While we were studying the subject of using gas, there was no better place than to make a collection of the different gas tubes. Here you see the results. A real lesson in hygiene and relative values! One gas pipe made of paper and wire, covered with cloth. It is bound to leak, but it only cost 3 cents a foot. There were several grades as the illustrations show, varying in price and quality, until we reached the best which is reliable. A good rubber connection, metal tubing inside which is well covered, not only to prevent gas from leaking, but for decorative purposes. This cost 15 cents per foot, but was well worth the difference because of the hygienic value.

Results of burning. Ventilation, results of breathing, carbon dioxide, food, medicines. We have an exhibition of 240 useless patent medicines taken from homes of students. Study of medicines, candies, etc. I am showing you an interesting laboratory experi-

ment performed by my students on penny candy. The material was collected and the experiments performed because the students saw something useful and worthwhile in this work. They were educating themselves to become better citizens and incidently preparing others to become better citizens, when they dyed the clothes of this doll with candy dyes.



1. 2. 3 4.

1. A gas-connecting hose made of paper over a wire spiral. Covered with cloth. 3c. to 5c. per foot. Very poor.

2. A gas-connecting hose made of a wire spiral. Covered with cloth, 10c. per foot. Fair.

3. A gas-connecting hose made of flexible metal. Covered with cloth and rubber. 12c. to 15c. per foot. Excellent.

4. A gas-connecting hose made of flexible metal. Uncovered.

(Courtesy Hinds, Hayden and Eldredge, Inc.)

The study of water follows that of food. Water supply, dangerous and good. Incidently the drinking fountain of the school building comes in for its share of criticism.

I hold in my hand two types of drinking fountains. One dangerous and unhealthy. It is so constructed as to allow disease bacteria of all kinds to collect. Children break their teeth on such fountains by pushing each other. It is a bubbling fountain and may easily spread disease. Here is another type made to prevent children touching the metal and breaking their teeth. It is clean, sanitary and wholesome.

Of course under this subject comes water pressure and the physical and chemical lesson as well as the lesson in hygiene. Bacteria

and disease naturally follow a subject of water. Light should get its share of attention next, since light is the greatest germicide known. The vital subjects of the pupil's environment must be taught and no general science should miss teaching Safety First.

In no part of school work is more practical psychology required than in the teaching of science. One of the chief faults of a teacher is to dominate a class, to talk too much. The ideal place for a teacher is in an out-of-the-way place in a class room, trying to keep still. The teacher may ask, "What am I paid for?" A teacher is paid to use his brains and keep his mouth shut as much as possible. This is the hardest job a teacher can have. It was a hard lesson for me to learn but I can conscientiously say I do pretty well after fifteen years of trying.

Enthusiasm is needed in every recitation. Pupils should fairly climb over each other to get into the science room. One day the history teacher came into my room just after the class had started, expecting to see something unusual. She said, "Will you kindly ask the class to go more quietly from my room to your room? They fairly walked on each other and they had been doing the same thing for several days." What had happened? Why, I had tried another experiment to get enthusiasm into the work. I had decided that one member of the class should conduct the class each day and that each one who wished should report on any observation they might have seen. In the first place I had a barometer, thermometer, and stormograph to be read and adjusted each day. Weather flags to be placed on a pole and weather charts to be read. Those who got into the room first reported on conditions.

Observations came next for ten minutes. These produced enthusiasm and many discussions. Here is where the teacher comes in. Do you know there seems to be an old feeling about teaching that we must ask a lot of questions? Is it not funny when we think of it? We are forever asking questions of others who may or may not know the answer when we know the answer. Why ask questions when we know the answers? When we want to know things in real life we don't know, we ask questions of those who do know. What an ideal method to use in class work. Let the student ask questions of the teacher instead of the teacher asking questions. Many a time one pupil knows a whole lot about some subject. How interesting and helpful to the whole class to have that student get out in front and let the class ask questions of the student. He is always glad to tell what he knows. Here is where the case system may be used.

The case system has been found valuable in teaching law and medicine. It is excellent for teaching general science. There was a time when the project method was in vogue. But no one today knows what a project is. We thought we knew once but since that time every idea and method under the sun has been called a project.

A boy or girl has some thing special to contribute. Let him do it and let the rest of the class together with the teacher, join in asking questions about the matter presented. The students get a sense of importance which communicates itself to other pupils, causing them to want to find something to contribute in like manner.

Why should a teacher do any of the experiments in science? Any one of his pupils will stay after school and prepare the experiment, study it and gladly explain it to the class the next day.

The recitation usually opens by a student's voluntary recitation as to the most important part in today's lesson and why; second of importance, why, etc. No one is called on. All recite because they want to. Each student rises and is recognized by the leader. Do they enjoy this recitation? They certainly do. They are not sitting in their seats waiting for the teacher to call on them. Their mind is on, what can I contribute? Interest is often stimulated by dividing the class into two groups and keeping account of each side. The students will see that every student contributes and if the teacher is wise he will see that the class is held to contribute essential things. The class is a good judge of this if you allow them to use their judgment as a whole.

To sum up in a word, general science is essential to the school as a medium of teaching a student more about the environment he lives in. It is also a medium for teaching students how to express ideas, to rely upon themselves for explanations when strange phenomena appear, to see more of the world about them and to ask questions about things. The grade pupil asks more questions about his environment than the average high school pupil of science, but you give the high school pupil the same opportunity and he will become a real live question mark.

The future of general science will be for the student and not the subject matter.

The world has advanced by finding real problems and solving them. To study means to solve vital problems. The average person does not have time to spend on anything but the real problems of his environment. General science must be and will be the source through which vital contact with the real things in nature are made.

General Science in the Junior High Schools of Massachusetts

W. G. Whitman, Normal School, Salem, Mass.

Superintendents and teachers have long been aware of the unsatisfactory condition of science teaching in the seventh and eighth grades. Here and there an enthusiastic nature-loving superintendent has evolved a helpful science program to meet local needs and the State Law requiring the teaching of physiology has compelled some attention to be given to that subject. But the majority of towns lack in the elementary schools any science courses which are satisfactory either to the pupil or to the teachers. With no definite outline suggesting profitable science work and with no text-books covering this field available, elementary school science has been drifting aimlessly for years.

School programs are frequently made out without including science or nature study except that enough physiology and hygiene are included to meet the State Law and even the law is scarcely met in many schools. This omission is not because the superintendent thinks that science is unimportant for nine out of ten superintendents with whom you talk say: "Yes, we ought to have more science in our elementary schools, but we have no teachers who can handle the subject." The chief reason that teachers are shy at teaching science is that they must make out the course, furnish the material, and do the teaching. Few teachers have the time and energy required for this so it is but natural for them to offer objections and to consider it a burden.

With the development of the junior high school and the readjustment to the program of studies the question of science is receiving renewed attention throughout the country. We find that serious attempts are being made to organize suitable science material to fill the gap that has existed so long between the nature study of the first six grades and the special sciences of the high school. Where no junior high school exists the problem of science in the seventh and eighth grades and the first year of the high school may be the equiv-

alent of a series of science subjects in the seventh, eighth, and ninth grades of the junior high school.

In order to determine the present status of science work in the various schools of Massachusetts a questionnaire was sent about a year ago to all the superintendents of the State. There were one hundred and eighteen replies. Data were obtained relating to science taught under these heads: Physiology and Hygiene, Nature Study, Elementary Science, and General Science.

The total time given to all science work including physiology, hygiene, elementary or general science, and nature study from the beginning of the seventh grade through the ninth grade or first year of the high school, is given in Table I. The totals are in week-year-minutes. For example: If a school gives sixty minutes per week to hygiene for a year in grades seven, eight, and nine, and three hundred and twenty minutes per week to general science in the ninth grade for one-half a year the hygiene counts 180 and general science 160, making a total equivalent to 340 minutes per week for one year or 340 week-year-minutes.

Table I. Time Allotment to Science. Grades VII. to IX. in 115 Massachusetts Schools.

No. of Schools.	*Week-Year-Minutes.*
4	700 or over
8	500 — 699
10	400 — 499
27	300 — 399
29	200 — 299
20	100 — 199
17	under 100

The wide range—from 40 to 740 week-year-minutes—indicates the chaotic condition of the present science teaching in the elementary schools. If we set 500 week-year-minutes as the standard, we see that only 10% of the schools meet the standard. A standard of 500 week-year-minutes would require about three periods per week in the seventh, fourth periods per week in the eighth, and four periods per week in the ninth grade, each period being 45 minutes in length. This is the time recommended by the Committee on the Junior High School for the High School Masters' Club of Massachusetts in their report of March, 1917. While few data on these grades for other states are available, the time allotment for some schools is at hand and may be used for comparison. See Table II.

Table II. Time Allotment to Science. Junior High Schools Outside Massachusetts.

	Kalamazoo Three Schools	Scottville	Rochester
Seventh Grade			
No. Per. per Week	2	2	2
Length of Period	45	45	45
Min. per Week	90	90	90
Eighth Grade			
No. Per. per Week	4	3	2
Length of Period	45	45	45
Min. Per Week	180	135	90
Ninth Grade			
No. Per. per Week	5	5	3
Length of Per.	45	45	90
Min. per Week	225	225	270
Minutes per Week			
Total in Three Years	495	450	450

The time given for Kalamazoo and Scottville is all devoted to general science; the writer has no information about how much time in addition is given to physiology and hygiene in these grades.

In Rochester, the first plan was to give general science in the seventh and ninth grades and physiology and hygiene in the eighth grade. This plan has been abandoned and a three years' course in general science adopted. The course includes considerable subject matter from the field of physiology and hygiene.

Table III. Time Allotment of Science Studies. Showing Naming and Grouping of Studies as Reported in the Questionnaire Answers.

	Number of Schools	Range (min. per week)	Average (min. per week)
Physiology and Hygiene	89		
7th Grade	87	15 — 200	48
8th Grade	89	25 — 150	50
9th Grade (or 1st. yr. high)	36	30 — 200	80
Nature Study (alone)	24		
7th Grade	24	10 — 200	58
8th Grade	23	10 — 150	45
9th Grade (or 1st yr. high)	18	30 — 300	160
General Science (alone)	6		
7th Grade	2	20 — 60	40
8th Grade	5	30 — 250	132
9th Grade (or 1st yr. high)	4	120 — 320	218

Nature Study and Geography ...	1		
7th Grade	1	150	150
8th Grade	1	120	120
9th Grade	1	135	135
Nature Study, Physiol. and Hyg.	5		
7th Grade	5	30 — 100	70
8th Grade	5	30 — 100	70
General Science			
9th Grade (or 1st yr. high) .	4	100 — 200	147
General Science and Nature Study	5		
7th Grade	5	10 — 60	33
8th Grade	5	10 — 150	48
9th Grade	5	10 — 300	120
General Science, combining El. Science, Nature Study, Physiol. and Hygiene	9		
7th Grade	9	30 — 150	90
8th Grade	9	30 — 150	90
9th (or 1st. year high)	7	15 — 290	130
General Science			
9th Grade	77		
	31	200 — 315	
	33	100 — 180	
	9	20 — 80	
	4	200 min. per wk. for one-half year,	

The following statement will suggest the interpretation of Table III. Out of a total of 118 schools, 89 give a course in physiology and hygiene separated from other science work; 87 of these give the work in the seventh grade. The time devoted to it varies from 15 to 200 minutes per week. The average time for the 87 schools is 48 minutes per week. All of these schools give physiology and hygiene in the eighth grade and 36 of them in the ninth grade.

Table III. shows as we would expect that physiology and hygiene are taught in more schools than any other science. But there is not as much time given to them in a single school as is given to nature study or general science where these studies are taught.

At the end of Table III. is listed general science for the ninth grade in 77 schools, not included in the other groups of Table III. In these 77 schools there is a wide range in the time given to the subject. It varies from 20 minutes to 315 minutes per week. Is there any good reason why general science should not receive at least 200 minutes per week in this grade?

Where physiology and hygiene and general science are given as separate course, there is bound to be much overlapping or from fear of overlapping omissions of valuable material. It has been suggested that it might be advantageous to organize a series of courses in general science running through the seventh, eighth, and ninth

grades, which should include the physiology, hygiene, nature study, elementary science and general science, which are so often given in fragments. Nine schools report that they are already doing this (see Table III.). In 1916 a committee of superintendents, working in conjunction with the Commissioner of Education, after consideration of the science problems of the elementary schools, voted to recommend that all science beginning in the seventh grade should be incorporated in and organized as a course in general science, extending through the several years of the school; this general science course is to include the physiology and hygiene.

The attitude of superintendents towards a grouping of all the science into a single general science course is best expressed by quoting their replies given to two questions of the questionnaire. They were asked to state what objections they could see to such a combination, also to state what advantages they could see in such a course. There were 100 who were in favor of one general science course which should combine all the science work. Six objected to the combination and twelve failed to register their preference.

OBJECTIONS TO CONSOLIDATING ALL SCIENCE INTO ONE COURSE.

"It will not give enough time to hygiene."

"I feel that hygiene should stand alone or with physiology or physical training."

"The ordinary teacher would make a hopeless hodge-podge of the course unless with a definite outline."

"Only cities and rich towns can get suitable teachers."

"Difficulty of securing competent teachers and proper equipment, especially in the small towns."

"I do not think I would combine hygiene with other science."

"Lack of trained teachers and suitable material."

"Instruction in physiology and hygiene is required by the State.

"Better combine them with physical training."

"Must be in the hands of skilful teachers."

"Chiefly the difficulty of trying to cover too much ground with immature children and teachers untrained in the subject."

"I do not see how it can be done within the time limits of the school day."

"Incapacity of teachers. Lack of suitable texts."

"Might result in too little attention to physiology and personal hygiene."

"Difficulty of getting a teacher with the right point of view."

"Usually such combinations run to hodge-podge."

The majority of those who offered objections to the proposed plan voted in favor of it.

ADVANTAGES OF CONSOLIDATING ALL SCIENCE INTO ONE COURSE.

"Correlation" (4) "Economy of time." (6).

"Would economize time and give better opportunity for correlation." (6).

"Saving of time both in preparation and in class work on part of teacher: More concentrated 'Food' for pupils."

"Saving of time and energy both for teacher and pupils."

"Elimination of duplicate material. Simplification of schedule."

"Some saving of time, better correlation, opportunity for first-hand observation."

"Interrelations would be made clearer. The subjects as a new unit would received merited attention more than at present incidentally."

"Time saver, definiteness secured, becomes a unit with aims."

"Better work and a saving of time."

"Correlation of matter and simplification of program."

"It would condense the work of the teacher and simplify the program."

"Uniformity, concentration, saving time, better teaching, and added importance to the subjects combined in the course."

"Excellent plan, it would tend towards less recitation periods."

"The work would be more systematic in all schools."

"Similar to our plan." "More concentration."

"The sciences are related and by taking them together as a definite course there is more freedom for consideration of real projects, and the course of study and program can be more definite."

"Uniformity, definite sequence."

"Better aims and methods."

"Good idea." "A good thing." "A good idea."

"I would heartily welcome such a plan. Its advantages are definiteness, system, a claim to recognition."

"Very desirable. Better organization of science work. Broader treatment."

"Accumulated interest and knowledge. A saving of time."

"Subjects will be more generally taught throughout the state."

"Will make it much easier for my rural teachers to arrange their program."

"A more definite space of time would be given."

"More likely to get definite results, especially when teachers are often changing."

"It would insure the teaching of certain subjects now neglected."

"When the course is properly adjusted it will constitute a unit."

"It is what we are planning to do."

"Gives continuity and articulates more closely. Lays the foundation in a broad field of very useful and necessary knowledge."

"That is essentially what we are now doing."

"Fine idea, wish I had such a course."

"Continuous interest. Unity."

"It might make an important subject from three or four unimportant ones and give the essentials of each co-related to each other, and adapted to pupil students."

"Would systematize this work. Give us a workable course for all schools."

"Probability of getting time for attention to each of these sub-divisions which would not be alotted to them separately."

"Insufficient time for separate continuous courses. Combined, emphasis can be given to different phases of the work at different times."

"Assures it a regular place in the curriculum."

"Will bring together work that should be organized together."

"More concentration, better instruction."

"It would tend to check our tendency toward infinite sub-division of subjects."

"Opportunity to vary the emphasis as needed." And to make the work continuous through the three years, seventh, eighth, and ninth grades."

"Helps teachers to appreciate relation of subjects and hence gives a better perspective to pupil."

"Properly taught it should open up to the child new interests that are at present neglected."

"More general knowledge, more helpful work in observation, greater cleanliness at home as well as at school."

"The child may have the instruction he needs when it will be of most value to him."

"Better preparation of our pupils for High School."

"Some knowledge of science for those who can not go to the High School."

"Many advantages if the common problems of the household are taken up."

"If well presented with a good text-book I think we should accomplish the work much better than now."

"We do this already."

"It would tend to correct the point of view of the ordinary teachers and break up the tendency to routine."

"More attention given to science and more work."

"As term implies General Science should include all sciences."

"The interrelating of these subjects makes it expedient to combine them. The opportunity of the teacher to explore the field of science without overlapping other subject matter is an advantage."

"Each helps the other." "Unity of subjects."

"Anything that will systematize and unify the work would be an advantage."

"Think it an admirable scheme." "Will economize time and energy." "Arouse interest in nature. Conserve nature's resources."

"Everything to its advantage. Something definite, that can receive its share of each day's time."

"More flexibility." "Systematizations."

"More variety of work which I think good."

"It is valuable for those who go no further than the eighth grade."

"A good foundation for later science work."

"Pupils in the grades learn more by having a variety."

"More complete and logical instruction."

"Training in clear thinking. Introduction to scientific experimentation and description. Correct life habits based upon well ascertained facts."

These reports from superintendents indicate three important facts. First: There is utter lack of uniformity of practice in science instruction in grades 7, 8, and 9. Second: The cause of the present weakness in elementary school science is due to the lack of qualified teachers and a suitable text. Third: Superintendents are almost unanimous in their desire to have a rather definite outline of suggestive science work for these grades and that it shall be organized so as to include the physiology and hygiene as well as nature study, elementary and general science.

To meet the demands and immediate needs, a rather extensive and suggestive outline of a science program for grades 7, 8, and 9 should be prepared. The normal schools should prepare teachers qualified to teach such a program of general science. With these two things done, the other failings of science will largely be removed.

The junior high school offers a favorable school organization for the development of a general science program. Out of 117 schools reporting 31 already have junior high schools and 35 others expect to have them soon. Almost half the towns and cities have one or more junior high schools now or contemplate having them soon. With prospects of a continued growth of the junior high school idea, it seems reasonable for us to prepare our science program with this school in mind and to prepare a three year plan.

The Making of a Match: a Project

CHARLES H. STONE, ENGLISH HIGH SCHOOL, BOSTON, MASS.

How much the progress of civilization owes to the use of fire, a moment's reflection will show. Without fire, our steamships and railroad trains must cease, mills and factories must shut down, cooking and heating in the home would become impossible. To a

small extent, electricity produced by water power could be substituted, but in the main it could not at present replace the gift which Prometheus brought from heaven to man.

The study of fire, then, becomes a project of first magnitude. There are many ways of approach but all ways must include an understanding of combustion, of the part played by the air in combustion, of kindling temperature, and that the oxygen necessary for the support of combustion may be obtained from certain substances in much more abundant quantity than it occurs in the air. Many other topics bearing upon the question will suggest themselves to the teacher.

A ready means of obtaining fire soon becomes a question of interest. The laborious method of the savage who obtains fire by rubbing two sticks together may be effective but hardly satisfactory. Nevertheless the savage has made use of friction as a means of raising his sticks to the kindling temperature, even though that temperature is rather high. But more readily inflamable substances are easily obtainable, and it is from these that the match of our project is made.

For sticks for the match making the unscorched ends of old matches may be used, or match sticks may be obtained from some manufacturer. One end of each stick is to be dipped in melted paraffin, not too hot. A mixture for the head is made by mixing in a small porcelain crucible equal parts of finely powdered potassium chlorate or nitrate and antimony trisulphide. [Note—Do not grind them together.] This mixture is then moistened with a drop or two of thin mucilage and thoroughly mixed into a rather stiff paste. The paraffined ends of the match sticks are dipped in this mixture, and a little manipulation will produce a fairly good head. These prepared matches are now to be thoroughly dried in some warm place.

For the striking surface a small piece of wood or of heavy pasteboard is coated over with a mixture of red phosphorus and fine white sand such as is used in glass manufacture. This mixture is moistened with a little mucilage and spread evenly upon the surface of the wood or pasteboard. It is then thoroughly dried.

When both match and striking surface are well dried, the match will easily be ignited by striking it upon the prepared surface.

Thorpe gives the following proportions for match head and for striking surface:

Head Composition.	Rubbing Surface.
Potassium chlorate, 5 parts.	Antimony trisulphide, 5 parts.
Potassium bichromate, 2 parts.	Red phosphorus, 3 parts.
Glass powder, 3 parts.	Manganese dioxide, $1\frac{1}{2}$ parts.
Gum, 2 parts.	Glue, 4 parts.

Code of Lighting School Buildings

By the following committee on School Lighting:
M. Luckiesh, chairman; R. B. Ely, L. O. Grondahl, J. D. Lee, Jr., F. Park Lewis, H. H. Madgsick, F. K. Richtmyer.

ARTICLE I. GENERAL REQUIREMENTS.—When in use, all buildings should be provided, during those hours when daylight is inadequate, with artificial light according to the following Articles.

Buildings hereafter constructed should be so designed that the daylight in the work space is reasonably uniform and the darkest part of any work space is adequately illuminated under normal exterior daylight conditions.[1]

ARTICLE II. INTENSITY OF ARTIFICIAL ILLUMINATION.—The desirable illumination to be provided and the minimum to be maintained are given in the following table:[2]

DESIRABLE AND MINIMUM ILLUMINATION

	Artificial lighting Foot-candles (Lumens per square foot)* At the work Minimum	Ordinary Practice
Storage spaces	0.25	0.5 — 1.0
Stairways, corridors	0.5	1.0 — 2.5
Gymnasiums	1.0	2.0 — 5.0
Rough shop work	1.25	2.0 — 4.0
Auditoriums, assembly rooms	1.5	2.5 — 4.0
Class rooms, study rooms, libraries, laboratories, blackboards	3.0	3.5 — 6.0
Fine shop work	3.5	4.0 — 8.0
Sewing, drafting rooms	5.0	6.0 — 12.0

ARTICLE III. SHADING OF LAMPS.—Lamps should be suitably shaded to minimize glare. Glare, either from lamps or from unduly bright reflecting surfaces, produces eye-strain.

*It should be borne in mind that intensity of illumination is only one of the factors on which good seeing depends.

†Under the column headed "Ordinary practice," the upper portion of the range of intensities is preferable to the lower; where economy does not prohibit. even higher intensities than those cited are often desirable.

[1] Daylight illumination values should be at least twice the value given in the Table, Article II. for artificial lighting.

[2] The illumination intensity should be measured on the important plane which may be the desk-top, blackboard, etc.

The method of computing the flux of light (lumens) required to do any desired illumination is described under the heading "Design of Lighting Installation" on page 101.

For more specific information regarding the lighting of shops, see "Code of Lighting Factories, Mills and Other Work Places", issued by the Illuminating Engineering Society.

[This Code of Lighting School Buildings was prepared by a committee of the Illuminating Engineering Society. It is the final revised code resulting from discussions, criticisms, and hearings on earlier drafts of the code during the last three years. The best thought of engineers, superintendents and teachers has been given to it. It contains material which can be used in a practical way in General Science classes in studying the schoolroom lighting problem.

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ARTICLE IV. DISTRIBUTION OF LIGHT ON THE WORK.—Lamps should be so arranged as to secure a good distribution of light on the work, avoiding objectionable shadows and sharp contrasts of intensities.

ARTICLE V. COLOR AND FINISH OF INTERIOR.—Walls should have a moderate reflection factor; the preferred colors are light gray, light buff, dark cream and light olive green. Ceilings and friezes should have a high reflection factor; the preferred colors are white and light cream. Walls, desk-tops and other woodwork should have a dull finish.

ARTICLE VI. SWITCHING AND CONTROLLING APPARATUS.—Basements, stairways, store rooms, and other parts of the building where required should have switches or controlling apparatus at point of entrance.

ARTICLE VII. EMERGENCY LIGHTING.—Emergency lighting should be provided at main stairways and exits to insure reliable operation when, through accident or other cause, the regular lighting is extinguished.

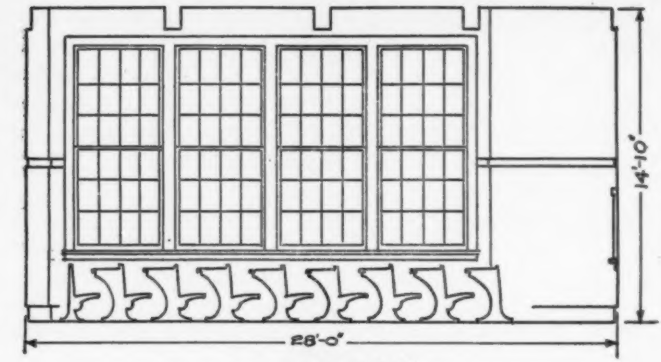
ARTICLE VIII. INSPECTION AND MAINTENANCE.—All parts of the lighting system should be properly maintained to prevent deterioration due to dirt accumulation, burned-out lamps and other causes. To insure proper maintenance, frequent inspection should be made at regular intervals.

DATA AND RECOMMENDATIONS

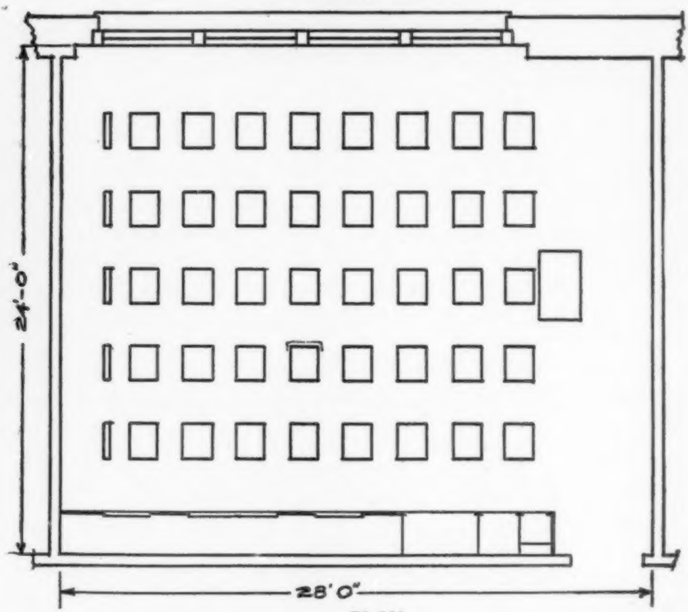
DAYLIGHT

INTENSITY OF DAYLIGHT.—In general, the minimum intensities of daylight illumination should be considerably greater than those provided in artificial lighting, owing to the adaptation of the eye to a much higher level of illumination (brightness) in the daytime.

DIRECTION OF LIGHT.—One of the fundamental rules for proper lighting of desks is to have the preponderance of light come from the left side. For this reason many school authorities advocate *unilaterial* lighting, that is, lighting by windows located on one side of the room only, especially for class rooms (see Fig. 1). This method of lighting is recommended where the rooms do not exceed about 24 ft. (7.9 m.) in width, with windows about 12 ft. (3.9 m.) high. If the rooms are much wider than this, *bilateral* lighting, that is, lighting by windows located on two sides of the room, may be required in order to provide sufficient illumination in every part of the room and at the same time to prevent too great a diversity of contrast in the intensity of light on the work spaces.



ELEVATION.



PLAN.

Fig. 1.—Unilateral daylighting. Scaled drawing of a typical modern class room.

To secure the highest lighting value it is recommended that the room be so designed that no working location is more distant from a window than one and one-half times the height of the top of the window from the floor.

Windows at the left and rear where practicable are preferable to those on the left and right sides of the room, because of cross shadows created by the latter arrangement. Lighting by overhead sources of natural illumination although sometimes used for assembly rooms, auditoriums and libraries, with relatively high ceilings, has ordinarily little application in class rooms and has found little favor in practice.

The sky as seen through a window is a source of glare. For this reason the seating arrangements should always be such that the occupants (pupils) of the room do not face the windows.

WINDOW OPENINGS.—Tests of daylight in well lighted school buildings indicate that, in general, the glass area does not fall below 20 per cent. of the floor area.

As the upper part of the window is more effective in lighting the interior than the lower part, it is recommended that the windows extend as close to the ceiling as practicable.

LIGHTING VALUE OF A WINDOW.—The lighting value of a window at any given location in the room will depend upon the brightness of the sky, the amount of sky visible through the window at the given location in the room, and indirectly upon the reflection factor of the surroundings and the dimensions of the room.

Observations in well lighted school rooms having a comparatively unobstructed horizon show, that under normal conditions of daylight, satisfactory illumination is usually obtained when the visible sky subtends a minimum vertical angle of 5° at any work point of the room.

In cases in which the horizon is obstructed, as by adjacent high buildings or by high trees, provision should be made for a larger window area than would otherwise be required; also if need be, for redirecting the light into the room by means of prismatic glass in the upper sashes of the windows, or by prismed canopies outside of the windows.

WINDOW SHADES.—Although direct sunlight is desirable in interiors from a hygienic standpoint, it is often necessary to exclude or diffuse it by means of shades. These shades should perform several functions, namely, the diffusion of direct sunlight, the control of illumination to secure reasonable uniformity, the elimination of glare from the visible sky and the elimination of glare from the blackboards wherever possible. These requirements make it desirable to equip each window, especially in class rooms,

with two shades operated by double rollers placed near the level of the meeting rail. The window shades may thus be raised or lowered from the middle, which provides the maximum elasticity for shading and diffusing the light. The shades should be preferably of yellow-colored material that is sufficiently translucent to transmit a considerable percentage of the light while at the same time diffusing it.

A more complete control of the light may be obtained by the use of two independent sets of shades at each window. Where two sets of shades are used, one should be preferably a very dark green of heavy material that will exclude the light entirely, and the other preferably a yellow-colored material as above described.

Different views of a window equipped with a single set of adjustable shades as used in the public schools of New York City are shown in Fig. 2. It will be noted that this method of installation permits of lowering the window from the top or raising it from the bottom without interference with the shades.

LIGHT COURTS.—Reflection of light from the walls of courts is very helpful in increasing interior illumination. Hence the walls of courts should have high reflection factors. Dark colors should be avoided.

MAINTENANCE.—Windows and overhead sources of natural light (so-called skylights) should be washed at frequent intervals and surfaces such as ceilings and walls should be cleaned and refinished sufficiently often to insure their efficiency as reflecting surfaces. It should be borne in mind that the maintenance of adequate daylight indoors is also dependent upon various external factors, such as the future erection of buildings and the growth of trees or vines.

ARTIFICIAL LIGHT

SYSTEMS OF LIGHTING.—It is customary to divide the systems of artificial lighting into three classes, namely, *direct, semi-indirect,* and *indirect.* This division is arbitrary and the boundary lines are quite indefinite.

A direct lighting system is known as one in which most of the light reaches the work plane directly from the lighting unit including the accessory which may be an opaque or glass reflector or a totally enclosing transparent or translucent envelope. Direct lighting systems may be further classified as *localized* and *general* or distributing. In the former the units are so placed as to light local

work spaces, and in the latter they are well distributed so as to light the whole area more or less uniformly.

A semi-indirect system is known as one in which a portion of the light reaches the work plane directly from the unit and a relatively large portion reaches the work plane indirectly, by reflection from the ceiling and walls. The accessory is usually an inverted diffusing bowl or glass reflector. When this glass has a high transmission factor the lighting effect approaches that of ordinary direct lighting, and when of low transmission, the effect approaches that of indirect lighting.

An indirect system is known as one in which all or practically all the light reaches the work plane indirectly after reflection from the ceiling and walls. The accessory is usually an opaque or slightly translucent inverted bowl or shade containing a reflecting medium.

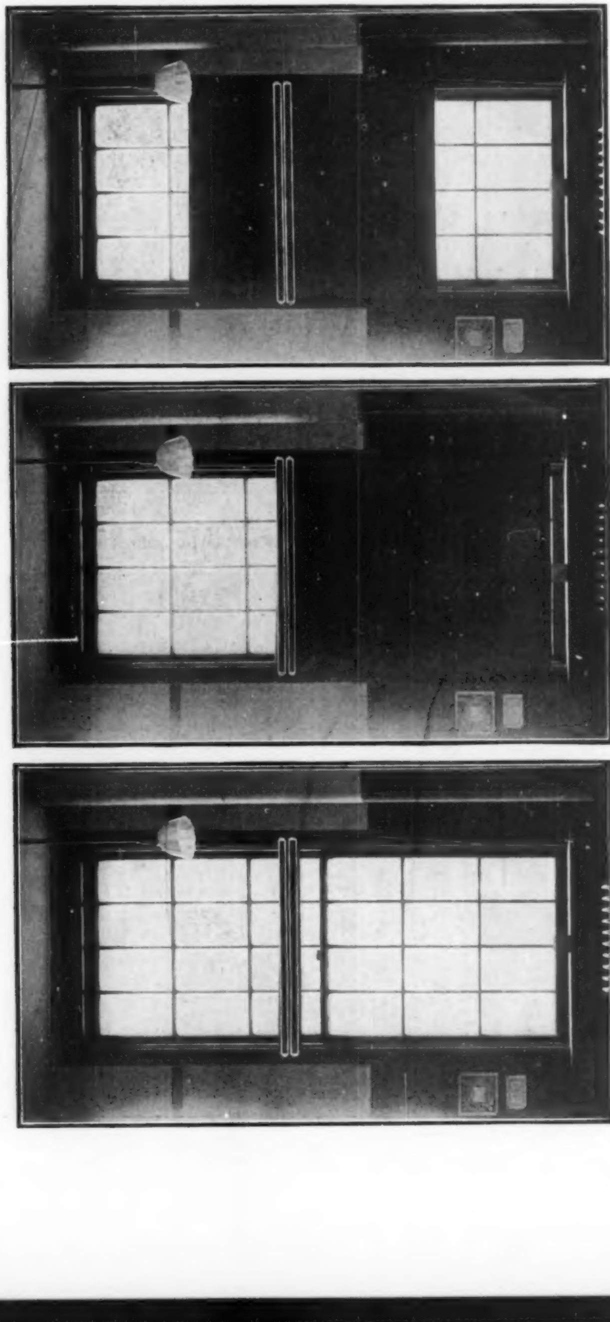
All three of these systems of lighting (illustrated in Figs. 3, 4, and 5) are in successful use in schools. There has been a growing preference for semi-indirect and indirect lighting, especially since the introduction of modern lamps of great brilliancy. Local lighting by lamps placed close to the work is unsatisfactory except for special cases such as the lighting of blackboards, maps, charts, etc. Examples of bad lighting are shown in Figs. 6, 7, and 8.

SHADING OF LAMPS.—Except in very rare instances bare light sources should not be exposed to view. They should always be adequately shaded or completely hidden. Even when shaded by translucent media, such as dense glassware, the lighting units should be placed well out of the ordinary range of vision; in other words it is recommended that lighting units be of low brightness,[3] even if they are located high in the field of view.

The maximum brightness contrast of juxtaposed surfaces in the normal visual field should be preferably not greater than 20 to 1; that is to say, the darkest part of the work space observed should have a brightness preferably not less than one-twentieth of that of the brightest part.

GLOSSY SURFACES AND EYE-STRAIN.—Glossy surfaces of paper, woodwork, desk-tops, walls and blackboards are likely to cause eye-strain because of specular or mirror-like reflection of images of light sources, especially when artificial light is used. Matte or dull finished surfaces are recommended. It is to be noted that a high

[3] Preferably not to exceed 250 millilamberts. A millilambert is equal to the brightness of a perfectly reflecting and diffusing surface illuminated to an intensity of 0.929 foot-candle, (0.929 lumen per square foot). It is also equal to 0.002 candle per square inch. (See bottom of p. 101).



A B C

Fig. 2.—Double-roller window shades as used in a public school building.

Fig. 3.—Good direct lighting.
In general, semi-indirect lighting is better for school rooms.

Fig. 4.—Good indirect lighting.

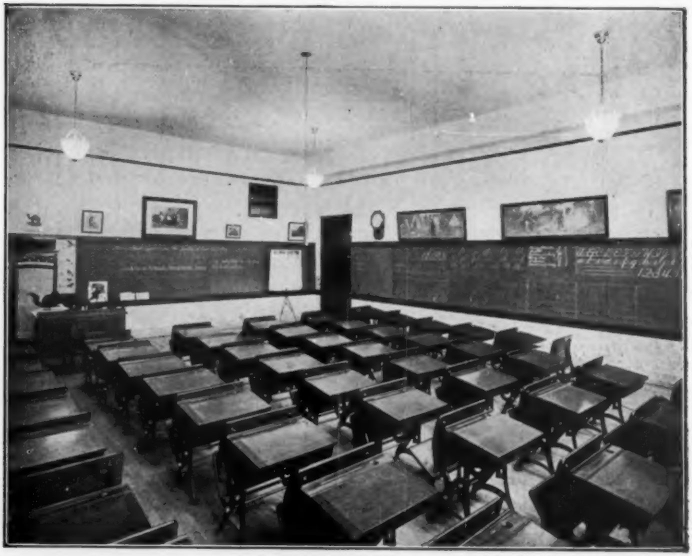


Fig. 5.—Good semi-indirect lighting.

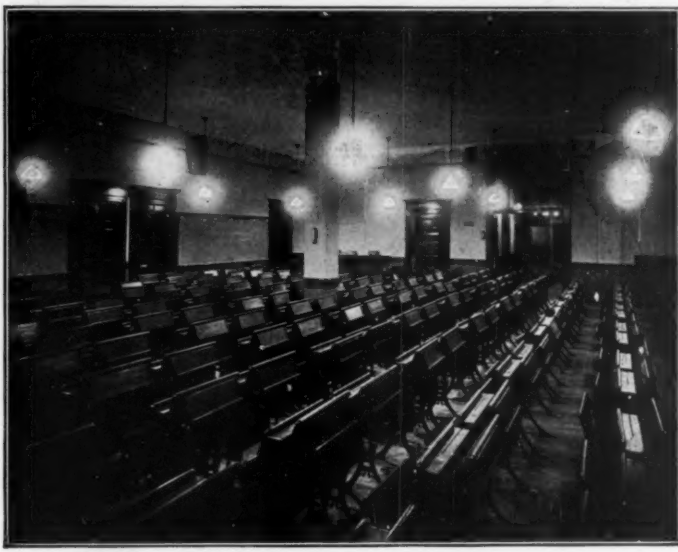


Fig. 6.—Bad lighting. The lighting units are hung too low and the light sources are not adequately shaded. Note the glossy varnished surfaces on benches and woodwork.

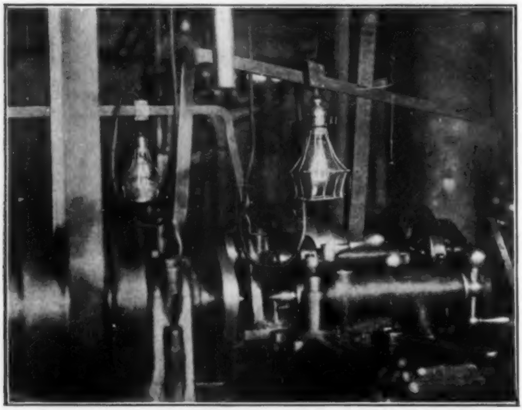


Fig. 7.—Bad lighting. The local lamps, if used at all, should be provided with reflecting shades to protect the eyes from glare and at the same time to direct the light to the work. General illumination by overhead units is preferable.

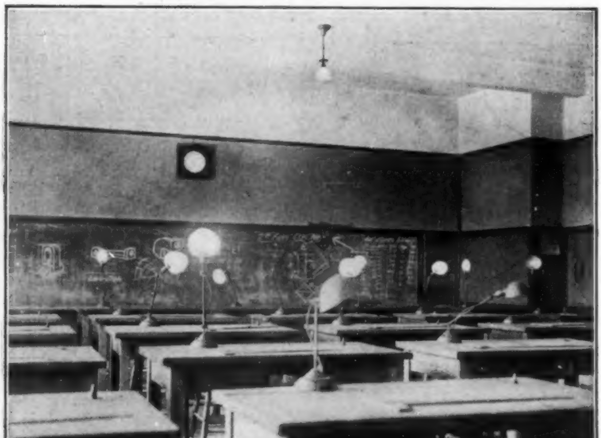


Fig. 8.—Bad lighting. The use of local lighting by adjustable table lamps usually results in glare from lamps on neighboring tables; also in annoying shadows. The difficulties may be overcome by the use of a system of general illumination.

reflection factor does not necessarily imply a polished or glazed surface.

To minimize eye-strain it is recommended that unglazed paper and large plain type be used in school books.

Children should be taught to hold their books properly, to assume a correct position relative to the light source, and to safeguard their vision.

COLOR OF LIGHT.—It has been found in practice that the admixture of daylight and artificial light is not satisfactory unless the latter is derived from lamps designed with special reference to producing daylight color values. Hence in warning daylight it is desirable to shut out the daylight and to use artificial light exclusively unless the lamps are of the type mentioned.

DESIGN OF LIGHTING INSTALLATION.—The illumination intensity on the horizontal work plane should be as uniform as possible. The variation should not be greater than 4 to 1.[4]

APPROXIMATE COEFFICIENTS OF UTILIZATION—MODERN LIGHTING EQUIPMENT

Small Rooms (Offices, Corridors, etc.)

	Light-color walls Light color ceiling	Medium color walls Light color ceiling
Direct lighting; dense glass (open bottom reflectors)	0.40	0.35
Semi-indirect lighting; dense glass	0.25	0.22
Indirect lighting	0.23	0.20
Medium Sized Rooms (Class Rooms, Laboratories, etc.).		
Direct lighting; dense glass (open bottom reflectors)	0.50	0.45
Semi-indirect lighting; dense glass	0.35	0.30
Indirect lighting	0.30	0.25

The following table shows the order of magnitude of the brightness of some light sources in common use:

	Approximate brightness Millilamberts	Candles per sq. in.
Indirect lighting: ceiling, directly above the lighting unit	5. to 75.	0.01 to 0.15
Semi-indirect lighting: heavy density glassware	35. to 100.	0.07 to 0.2
Semi-indirect lighting: light density glassware	200. to 1,000.	0.4 to 2.0
Direct lighting: 10 in. (25 cm.) opal glass ball containing 100-watt vacuum tungsten lamp at center	250. to 500.	0.5 to 1.0
Direct lighting: vacuum tungsten lamp, (frosted) in open bottom reflector	2,000. to 3,000.	4. to 6.
Vacuum tungsten lamp, filament exposed to view	500,000.	1,000.
Gas-filled tungsten lamp, filament exposed to view	2,000,000	4,000.
Gas-mantle, bare	15,000.	30.
Gas-mantle concealed in 6 in. (15 cm.) opal glass globe	1,000.	2.
Mercury arc tube (glass)	8,000.	16.
Daylight: clear blue sky	1,000.	2.

Large Rooms (Auditoriums, etc.).

Direct lighting; dense glass (open bottom reflectors)	0.62	0.60
Semi-indirect lighting; dense glass	0.43	0.40
Indirect lighting	0.40	0.38

The chief factors which must be considered in arriving at the size and number of lamps to be used in a given room are (1) the floor area; (2) the total luminous flux[5] emitted per lamp, and (3) *coefficient of utilization* of the particular system considered. The first should be measured in square feet. The second may be obtained from a data book supplied by the manufacturers of lamps. The third involves many factors such as the relative dimensions of the room, the reflection factor of the surroundings, the number of lighting units and their mounting height, and the system of lighting. By *coefficient of utilization* is meant the proportion of the total light flux emitted by the lamps which is effective on the work plane. In the accompanying table approximate coefficients of utilization for modern lighting equipment are given. The work plane in this case is a horizontal plane 30 in. (76 cm.) above the floor. These values refer to the initial installation without any allowance for depreciation.

For determining approximately the size and number of lamps to be used in a given room by means of the coefficients of utilization given in the preceding table, it is necessary to know the luminous output in lumens per watt for the electric lamps considered or in lumens per cubic foot of gas consumed per hour if gas lamps are considered. At the present time (1917) the light output of tungsten filament electric incandescent lamps, based on average service conditions of regularly maintained installations, ranges from 8 lumens per watt for the smaller vacuum tungsten lamps to 14 lumens per watt for the larger gas-filled tungsten lamps employed in school lighting. For incandescent gas systems similar service values range from 150 to 250 lumens per cubic foot of artificial gas consumed per hour. The computation for the total lumens required to give a certain illumination intensity in foot-candles is as follows:

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4 This ratio refers to the light received by the object illuminated and should not be confused with the ratio of 20 to 1 for brightness contrast previously given on page 96 which refers to the light radiated by the object. For example, a blackboard and a white sheet of paper on it may receive the same amount of light, but the latter will reflect much more light than the former, thus causing a marked brightness contrast between the two surfaces.

5 The flux is measured in lumens. A lumen is the unit of light flux and is the quantity of light required to illuminate 1 square foot of area to an average intensity of 1 foot-candle.

N=number of lamps.
L=lumens output per lamp.
E=coefficient of utilization.
A=area of floor or horizontal work plane in square feet.
I=illumination intensity in foot-candles.

$$\frac{N \times L \times E}{A} = I$$

that is, the number of lamps multiplied by the output per lamp in lumens, multiplied by the coefficient of utilization, divided by the area of the horizontal work plane in square feet, gives the illumination intensity in foot-candles.

If the size of the lamps is to be ascertained the computation is made thus:

$$L = \frac{I \times A}{N \times E}$$

To illustrate by an example, assume a room, whose floor (also work plane) is 30 ft. by 18 ft. (9.1 by 5.5 m.), to be lighted by a semi-indirect system from six fixtures containing one lamp each. It will also be assumed that the ceiling is highly reflecting, the walls moderately reflecting, and the illumination intensity desired is 5 foot-candles. The luminous output required of each of the six lamps will be found by substituting the assumed values in the equation, thus:

$$L = \frac{5 \times 30 \times 18}{6 \times 0.30} = 1{,}500 \text{ lumens}$$

Allowing a depreciation factor of 20 per cent. as representing a well maintained installation, the lumens actually required would be $\frac{1{,}500}{0.8} = 1{,}875$ lumens. If gas-filled tungsten lamps are considered, whose average output under service conditions is 12 lumens per watt, it is seen that a 150-watt lamp in each fixture will give the desired results.

If gas mantle lamps are considered, whose average output in lumens under service conditions is 250 lumens per cubic foot of gas consumed per hour, it is seen that a lamp consuming 5 cubic feet of artificial gas per hour will be satisfactory in each fixture.

The above example is intended solely to illustrate the method of computation. Estimates of the illumination intensity obtained from an actual installation may also be made by a similar computation.

Suitable switching and controlling arrangements should be made to permit of lighting one or more lamps independently as conditions may require.

The teacher's desk may be illuminated by one of the overhead lighting units, or if necessary, by a desk lamp.

With the usual lighting equipments the distance between the units should not exceed one and one-half times the height of the apparent source of illumination above the working level.

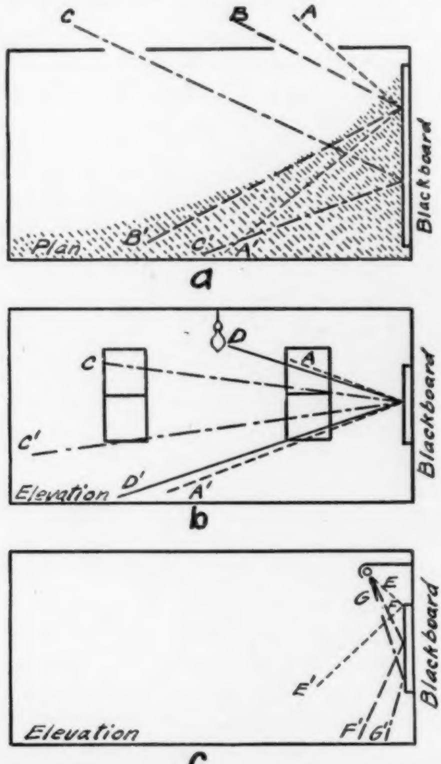


Fig. 9.—Diagrammatic illustration of glare from blackboards.
(a) Showing that occupants of seats in shaded area are subjected to daylight glare from blackboards.
(b) Showing angles at which glare is experienced from daylight and from artificial light.
(c) Arrangement of local artificial lighting to minimize glare.

BLACKBOARDS.—Blackboards should be of minimum size practicable and should not be placed between windows. Their posi-

tion should be carefully determined so as to eliminate the glare due to specular reflection of images of either artificial or natural light sources directly into the eyes of occupants of the room. The surface of blackboards should be as dull as possible and this dullness should be maintained.

Glare, due to specular reflection from blackboards, may be reduced or eliminated by lighting them by means of properly placed and well shaded local artificial light sources.

In Fig. 9 are shown some simple graphical considerations of blackboard lighting. In (*a*) is shown a plan view of a room with windows on one side. Rays of light are indicated by A, B and C in a horizontal projection. These are supposed to come from bright sky. By the application of the simple optical law of reflection—the angle of incidence is equal to the angle of reflection—it is seen that pupils seated in the shaded area will experience glare from the blackboards on the front wall. In (*b*) is shown the vertical projection of the foregoing condition. It will be apparent from this graphical illustration that by tilting the blackboard away from the wall at the top edge, the pupils in the back part of the room will be freed from the present glaring condition. Whether or not this tilting will remedy bad conditions may be readily determined in a given case. In (*b*) the effect of specular reflection of the image of an artificial light source is shown by D. In (*c*) is shown a proper method of lighting blackboards by means of artificial lighting units. This will often remedy bad daylight conditions whether due to an insufficient illumination intensity of daylight or due to reflected images of a patch of sky.

In order to avoid excessive brightness contrast which is trying to the eyes, blackboards should not be placed on a white or highly reflecting wall.

REHABILITATING THE LIGHTING OF OLD BUILDINGS.—This will be illustrated by an actual case where the artificial lighting of a class room was made satisfactory at a small expense. In Fig. 10 the two circles containing crosses indicate the position of the two old fixtures in this room. The chief objections to this old system were as follows:

(1) The lighting units were hung too low, so that eye-fatigue resulted from the bright sources in the visual field.

(2) The light sources were not shielded from the pupils' eyes.

(3) Two fixtures are insufficient to provide satisfactory illumi-

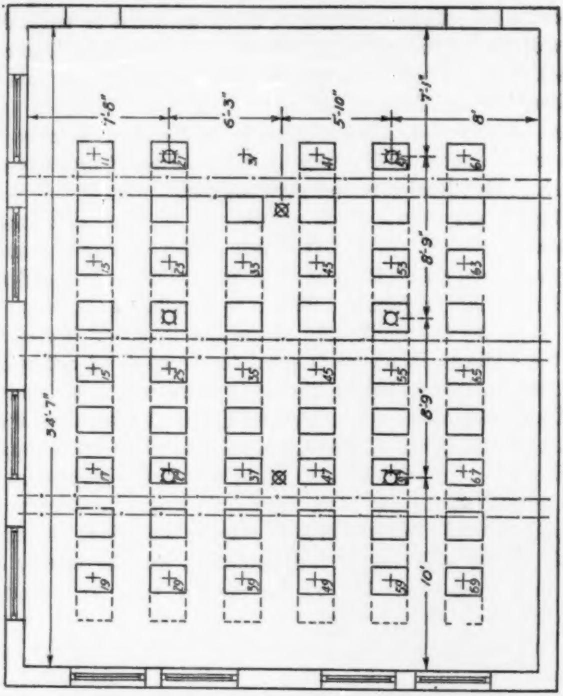


Fig. 10.—Old and new outlets for artificial lighting equipment in a class room.

nation over the entire work plane in a room of the dimensions shown. This unsatisfactory condition was remedied by means of six fixtures placed as indicated by the six circles. The fixtures consisted of inverted diffusing glass shades containing one lamp each. The dimensions of the room are shown in the illustration.

MAINTENANCE.—A systematic maintenance should be provided in order to insure against depreciation in the illumination intensity due to burned-out lamps, broken gas mantles, discoloration, etc., and to accumulations of dirt upon the lamps, and upon the surfaces of the reflecting and transmitting media. It is found in practice that carelessness in this respect may easily reduce the effective illumination by 50 per cent., especially in indirect and semi-indirect lighting.

The Project of a Frozen Water Pipe

Edited from a Boy's Note Book By JOHN FRANCIS WOODHULL.

According to the weather bureau records, the average temperature for the month of January, 1918 was 21 degrees, which is nine degrees below the average for that month during the last thirty-three years.

The unusual cold of this winter caused many water pipes in our neighborhood to freeze and we watched with interest the temperature of the water in our own pipes, testing it each day with a thermometer. During the fall the temperature went down quite steadily at the rate of five or six degrees a month until on January 14th it reached 36 degrees, only four degrees above the freezing point. Then it ceased to fall, remaining stationary for 55 days until March 10th. The temperature of the air during these 55 days ranged from —10° to 60° but the temperature of the water in our pipes in the ground did not vary from 36°.

On the 21st day of last December we lowered into the iron tube, called a "curb-box," which is connected with our water pipe at the sidewalk, a string of four small bottles, each filled with water and corked. The lowest one rested upon the water pipe which is 38 inches below the surface of the ground, and the upper one was suspended just beneath the iron cap at the surface. By the fourteenth of January all of these bottles of water had frozen solid and broken except the lowest one, which was entirely free from ice and remained so all winter.

On the tenth of March, the day when the temperature of the water in the pipe first began to rise, we found by using a crowbar, that the frost had left the ground in most places. The ice had also for the most part left the reservoirs and ponds of our neighborhood.

A neighbor, whose water pipe froze early in January, carried water in pails for all the purposes of his household for many days, hoping all the while that a warm day would thaw out his frozen pipe. At length he grew hopeless and engaged the electric light company to thaw out his pipe.

How may an electric light company thaw out a frozen water pipe?

When the representatives of the company came, one of the men climbed a pole which stood in front of the house on which was an iron cabinet, called a transformer. This transformer was explained by the men as follows:

Electric currents flow through wires with difficulty. In order to bring the electric current to this house from the dynamo at the central station, two miles distant, it is necessary to have it sent under high pressure (or *voltage* as it is called). The wires which lead into the transformer in front of this house have an electric pressure of 2750 volts, which would be dangerous to bring into the house. The transformer reduces this pressure to about 110 volts, or one twenty-fifth of the voltage in the main wires. This is considered safe for use in the house. Two parallel illustrations helped to explain the transformer. 1. A certain train is drawn by a locomotive whose boiler generates steam at a pressure of 250 pounds per square inch. While this is necessary for *propelling* the train, it would not be safe to use such high pressure steam for *heating* the cars. Hence a *"reducing valve"* is used to reduce the steam pressure from 250 to, say, 10 pounds per square inch for use in the steam pipes in the passenger cars. The electric transformer has a very similar use to that of the reducing valve in a steam equipment. 2. For a second analogy to explain the transformer, there was cited the case of a city water supply, in which water is supplied to the mains at a very high pressure. This pressure is very useful at the hydrants in case of fire, but hot water tanks in houses cannot withstand it. In such cases tanks are sometimes installed in the houses, so constructed that they transform the high pressure to a moderate and useable one.

The man who climbed the pole attached two long heavy copper wires to that side of the transformer which gives 110 volts. One of these wires he brought in contact with the water pipe through the curb box, and the other was attached to the water pipe within the house. The intention was to force a large electric current through the water pipe running from the street to the house and warm it sufficiently to thaw the ice. We inquired of one of the men how large an electric current he would use and were told 10 amperes. The other man, however, said it was 10 amperes on the primary, or high tension side of the transformer, but 250 amperes on the secondary, or 110-volt side. When the quantity of current is *stepped up twenty-five fold* the voltage is *stepped down twenty-five fold* by the transformer.

Two hundred and fifty amperes at 110 volts is about the quantity required to heat 50 electric flatirons or to light 750 incandescent lamps such as we use.

We asked how long it would take for 250 amperes at 110 volts to start the water and were told 10 minutes. These figures indicate

that about 4.6 kilowatt-hours of electricity would be required which would be worth about 46 cents. The electric company charged for this service $15 and failed at that to make the water run.

The neighbor continued to carry water. After many days, however, he again applied to the electric light company. They came down to make a second attempt and this time undertook to send the electric current through that portion of the pipe which runs under the street from the water main to the curb. They made connections with the water main by attaching one wire to a hydrant nearby and the other wire was connected with the house service pipe at the curb box. Again 46 cents worth of electricity was used for which they charged again $15, but no water ran into the house. Whereupon it was decided that the pipe was split by freezing and when the ice was melted by the electric current the water simply ran away into the ground. A plumber was then engaged to come and dig up the pipe. When he broke through the frozen ground a flood of water came up.

It was found that when this house was built, the plumber had laid the pipe in some places not more than two feet below the surface of the ground, but now he charged $100 for repairing it.

In our lawn, near the line of our water pipe, is a lilac bush. Its buds grow slowly all winter. This does not seem so strange when one reflects that its roots reach down where the temperature never gets below 36°. Indeed the extreme variation of temperature between winter and summer for those roots, as shown by the temperature of the water in our pipes is only 33 degrees, never getting above 69° in summer nor below 36° in winter.

Frogs spend the winter in the mud at the bottom of the ponds. Perhaps they never experience a lower temperature than 36°. They come forth in March very soon after the temperature of the water in our pipe begins to rise above 36°.

A rat spent the winter in a burrow underneath our hen house. The temperature in the hen house fell as low as 14° one day last winter. Perhaps the rat in his burrow suffered nothing colder than 36°. Nor is his burrow damp. The trench which the plumber dug last winter was dry and dusty below the frost line. Mammoth Cave is for the most part dry. Hence houses for consumptives were built in there many years ago. A mile of wooden water pipes with iron bands laid in the cave more than a century ago, and long since abandoned, are dry and in as good condition today as ever. An underground vault keeps our books and papers entirely dry *if it is not ventilated.*

As we have already said, the temperature of the water in our pipe went down during the fall at about the rate of 5 degrees a month until, in the middle of January it reached 36°. After which it remained constant for nearly two months. Then, the frost being out of the ground, it began to rise, and, during the spring months, it rose at the rate of about 10 degrees a month, about twice as fast as it had declined in the fall. This is presumably due to the warm rains of spring which sink into the earth and carry the heat to considerable depths.

An experiment was performed to parallel the temperature changes in the earth as follows:

We put a thermometer in a bottle containing a pint of water and set it out doors on a cold day when the temperature of the air was 6°. The thermometer in the bottle of water went very slowly down from 68° to 32° where it remained stationary for a whole day until the water all turned to ice, after which it slowly descended to the temperature of the air around. The next day the bottle was brought into the house and kept in a warm room where the temperature was 68°. The thermometer in the bottle of ice rose very slowly until it reached 32°, and there it remained all day until the ice was nearly all liquified when the temperature began to rise and continued to rise very slowly until it reached the temperature of the air of the room.

So it is that the earth, saturated with water during the late fall begins to freeze and at a depth of three feet in our region (Yonkers, N. Y.), animals and roots of plants, as well as water pipes are protected from a temperature lower than 36°. Although the temperature of the air may fall far below that point. One pound of water changed to ice liberates as much heat as would be required to raise 144 pounds of water one degree. In New York City this setting free of latent heat by the changing of the water of the bay and rivers to ice keeps the winter climate mild. It keeps the average for January from going much below 30°. It makes the temperature tend to rise toward 32° during a snow storm.

In the last half of our experiment a pint bottle full of ice (1 pound) remained in a warm room all day and did not rise in temperature above 32° until it was nearly all liquefied. During this time it was absorbing from the room 144 units of heat (called Brit-

ish thermal units). When 100 pounds of ice is put in the household refrigerator it must absorb 14,400 B. t. u., of heat from the food. etc., before it can all change to water. This may require a week under certain conditions.

On March 1, 1914 there was a fall of snow in the vicinity of New York City and by the middle of April, six weeks later, some of that snow was still lying on the ground. None had fallen since March 1st. There had been many warm days during those six weeks and on some portion of every day the temperature had risen above the melting point. In all that time the snow was unable to get the 144 B. t. u. of heat which each pound of it must have before it could change to water.

The ice in the ground over our water pipe absorbed all the heat from the sun until March 10th, passing none of it on to the water pipe. The sun was approaching the vernal equinox when its heat first began to penetrate the soil to a depth of three feet.

An Introductory Lesson Leading to a Study of Science About the Home

Dessie P. Spangler, Pittsburgh, Pa.

Teacher: "Class, this morning I am going to give you a name and I want you each to tell me *a word* it suggests to you. The name is (hesitate, so every one is alert), Benjamin Franklin."

(I shall count mentally twenty before asking for words.) No doubt at least fifteen words will be given, among them *kite, lightning, electricity.*

Teacher: "John, what made you think about kite?" John will no doubt tell the story about the discovery of electricity. Just what I want him to do.

Teacher: "Men for ages had seen lightning. How did Benjamin Franklin differ from other men in this respect?"

The answers to this will bring out such words as *curious, thought, experiment.* These, I shall write on the board and add to them *seeing, hearing, observation.* At the same time giving a few comments on the benefits the world has received from Franklin's *observation, curiosity, thought* and *experiment.*

Teacher: "Electricity has become a very efficient servant for man. How many of you have it for a servant in your home?" (This will bring a ready response, some thing like the following):

"Mary, you said the telephone. How does electricity save you labor by using the telephone?"

Mary: "This morning, Mother had an order of groceries. She gave the order over the telephone to deliver them at noon. If we had no phone, I should have had to go to the store after school this afternoon and the groceries would have been delivered tomorrow."

Teacher: "Were they delivered in an auto truck?"

Mary: "Yes."

Teacher: "Electricity served again."

Teacher: "George, how does electricity serve your home?"

George: "By lighting the house."

Teacher: "What do you do to aid electricity to do this?"

George: "Turn a button."

Further conversation will bring out the electric iron, washer, bell, toaster, etc.

Teacher: "Now class, in order to make this work a success this year we must become like Franklin; i. e., we must observe, we must be curious, we must think and if we do these three, we shall want to experiment."

Teacher: "How many of you remember your having solved a difficult problem without any help and how pleased you were over having solved it yourself? That is one secret of success and pleasure in this work, thinking and finding out things for yourself."

Teacher: "*Now* I'll tell you what we are going to do this next week. We are going to buy a lot and build a house for a family of six, father, mother, fifteen-year-old boy, thirteen-year-old girl, an eight-year-old girl and a baby boy, three years old.

"Since the standard sized lot in our town is 50x150, we shall choose one that size. Each of you lives in one of the four wards of the town. After school this afternoon, you take a survey of your ward and select what you think is the most desirable lot. Tomorrow tell us where it is located and give reasons for your selection. Then as a class we shall take a vote on the lots. After school tomorrow evening, as a class we shall visit the lot selected and determine where is the best place to build the house.

"I think our adopted family should have a name. George, you may select the family name. Mary and Jane, select names for the girls and Henry and James for the boys. (This adds interest and makes it more real.)

"In building the house, we must not only consider the family but their valuable servants, electricity, sunshine, heat, air and water."

Some Suggestions for the Study of Our Food Supply

Marion D. Weston, Rhode Island State Normal School.

The following study of Our Food Supply was made this fall by members of the general science class of the Rhode Island Normal School. The course is taken during the first half year in normal school by students who have had both physics and chemistry in high school.

Selection of Unit

Our Food Supply was selected for the first unit after deciding, as a class, that it answered the requirements of a general science unit: general science because it is the study of one important phase of the "natural environment" which would help in meeting every-day problems; unit because it could be taken up as a "main topic to be developed by projects, experiments, demonstrations and discussions."

Organization

Although the unit itself was suggested by the teacher, the organization was placed almost entirely in the hands of the students. The following list of topics was jotted down on the blackboard as they were suggested by members of the class:

Food Administration	Wheat
Food Preservation	Meat
Uses of Food Principles	Sugar
Labor Problems connected with the Food Situation	Fats
	Belgian Relief

Two or three girls signed for each topic, dividing it among themselves to avoid duplication of work.

Method of Presentation

The order in which the topic should be given was arranged by the class. Each student gave her report from a brief outline, placed on the board before class, without reference to other notes. With the exception of the first few topics these outlines were not criticized before they were given to the class, suggestions regarding form and subject matter coming in naturally after the presentation.

Brief notes with the outline as a framework were taken by all members of the class. In order to focus attention on important

principles, which particularly needed emphasizing, a few questions would frequently be asked by the teacher at the close of the topic. If the points had not been thoroughly made time was then taken to supplement the report by additional material, the points thus emphasized being made the basis of the very brief written quizzes which were given each week. The following outlines will suggest the general trend of the reports:

THE FOOD ADMINISTRATION

I. Need.
  A. War used up reserve supplies.
  B. Men drawn from the farms.
  C. Conditions in Europe.
    1. Nearly all Belgian beet land and 7-8 of French sugar land in hands of Germans.
    2. Wheat region in South Russia cut off.
II. Organization.
  A. April 10, 1916.
  B. Hoover made head.
  C. Purpose—Regulate food supply in order to supply the Allies.
III. Food Substitutes.
  A. Potato—1-4 as much food value as wheat. Cannot be shipped—Water freezes.
  B. Corn—Must be consumed when fresh.
  C. Dairy products.
  D. Cereals.

PRESERVATION OF FOODS

I. Necessity for preserving foods.
II. Consideration of the various means of preservation.
III. Canning of fruits and vegetables.
  A. Cold pack process.
  B. Open-kettle method.
IV. Drying of fruits and vegetables.
V. Preservation of fruits and vegetables by fermenting and vinegar pickling.

FATS

1. Need of fats in the body.
  A. Energy production.
  B. "Growth determinants" (Vitamines).
    1. Repair of old tissue.

2. Growth of new tissue.
C. Conditions in warring nations.

II. Approximate fat consumption.
A. Amount each uses, 3¼oz. per day.
B. Each needs 2 oz.

III. Waste of fats.
A. Amount in city garbage, 35-40 pounds per ton.
B. In cooking.

IV. Elimination of waste of fats.
A. Reducing use of cream by using top milk.
B. Eat all fat in milk or clarify it.
C. Use recipes calling for small quantities of fat.

LABOR SHORTAGE

I. The laws passed forcing able-bodied men to work or fight.

II. Women and girls taking the places of men in factories, offices and on farms.
A. The "farmerettes."
1. Duties.
2. Regulations.
3. Wages.
4. Work.
a. In spring.
b. In summer.
c. In autumn.
B. Benefits received by women and girls who have thus helped to relieve the labor shortage.
C. Summary and account of the "Farmerettes" of Hope Valley, Rhode Island.

LIFE OF HERBERT C. HOOVER

(Sub-topic under Belgian Relief).

I. Birth and early life.
A. 1875, Iowa.
B. Placed in care of relations.
C. Own set of principles.

II. Education.
A. 1891. Stanford University.
B. Graduation—Mining in Grass Valley.
C. Life in San Francisco.

III. Work in foreign Countries.
A. Australia—development of mines.

B. China—changing of mining methods—Boxer uprising.
C. London—junior partner.

IV. Accomplishments while in business for himself.
A. Russian reorganization.
B. Breaking out of war—Helping Americans.
C. Work in Belgium.
D. Head of United States Food Administration.

SOURCE OF MATERIAL.

Material for the topics was necessarily obtained from a wide variety of sources; books, government pamphlets, magazine articles, newspaper clippings and the like. Although the government bulletin, Ten Lessons on Food Conservation, 1917, gave valuable suggestions in the way of organization of topics the fact had to be constantly emphasized that statements true in 1917 were frequently misleading or false in 1918.

PROJECT WORK

In addition to the presentation of the topic each student selected a project to be worked upon outside of class. The list follows: (Many of the projects were suggested by the girls.)

Making a sterilizer for canning.
Making an ice box for milk.
Making apparatus for drying foods.
Making fireless cooker.
Testing candies for coloring matter.
Making tests for food principles.
  Testing 10 foods for protein.
  Testing 10 foods for starch.
  Testing 10 foods for sugar.
Finding out work of digestive juices.
  What happens to starch in the mouth.
  What happens to meat in the stomach.
  What happens to starch and meat in the small intestine.
Finding reasons for wrapping foods in waxed paper whenever practicable.
  Bread wrapped; unwrapped.
  Candy wrapped; unwrapped.
Testing samples of milk for number of bacteria.

A word of explanation is necessary concerning the experiments on bacteria. During the work on the sanitation unit demonstrations had been given of examination for bacteria in milk and water and

on hands before and after washing. The girls were thus familiar with the method for similar experiments involving gelatin media in petri dishes. The girl who suggested the bread experiment plans to rub pieces of crust from a loaf of bread, which had been delivered unwrapped, over one gelatin plate and crust from a second loaf, protected by paper, on another plate. The counting of the number of colonies of bacteria on the two plates is expected to throw some light on the comparative cleanliness of the two methods. The writer does not know how the experiment will come out but feels it to be investigation along a line worthy of general science.

FOOD DEMONSTRATION

A demonstration was given at the local Food Administration Room for the benefit of the class, a double period being devoted to the purpose. As this came late in November the subject chosen was "Some Suggestions for Thanksgiving." At the close of the demonstration a visit was made to the Hoover Hut where the food exhibit which had been used at the State Fair was still to be seen. At the following lesson the class was asked to write on the question: "Justify the giving up of two periods of general science time to the work accomplished during the trip." The following answer brings out most of the points the writer hoped the girls would get from the trip.

"The trip to the Strand Building and Hoover Hut during class time is justifiable: 1. The conservation of food and the doings of the Food Administration are questions of importance to the student of science. 2. We are still asked to conserve food and it is just that we should be told how we can save it. 3. By visiting the rooms and seeing the work done the idea is made more real to us and it arouses our interest more than if we only discussed it in class. 4. It is very probable that we shall be asked to save food after Europe has straightened out its food questions, as it is sinful as well as wasteful to consume the large quantities of food that the Americans have consumed in the past. 5. We, as future teachers, will need to talk about it to the children, and a visit of this sort will help us out a great deal as it will give us an idea of how to go about it."

CURRENT EVENTS

Once a week each girl is prepared to give a one-minute report on something of current interest in the broad realm of general science. This material is selected at home or from articles posted on the class bulletin board which is arranged each week by a committee of three or four girls.

Hot Water Heating

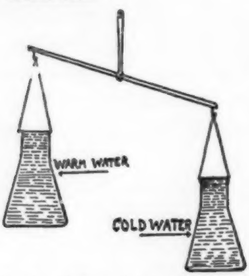
J. RICHARD LUNT, ENGLISH HIGH SCHOOL, BOSTON.

The following project is included in the General Science course at the English High School of Boston.

Experiment I. How heat effects water.

Heat the water in the flask as shown in the diagram. Water rises in the glass tubing. Let the water in the flask cool. Water in the glass tubing falls.

Experiment II. Balance two flasks of the same size. Fill one with warm water. Fill the other with cold water.



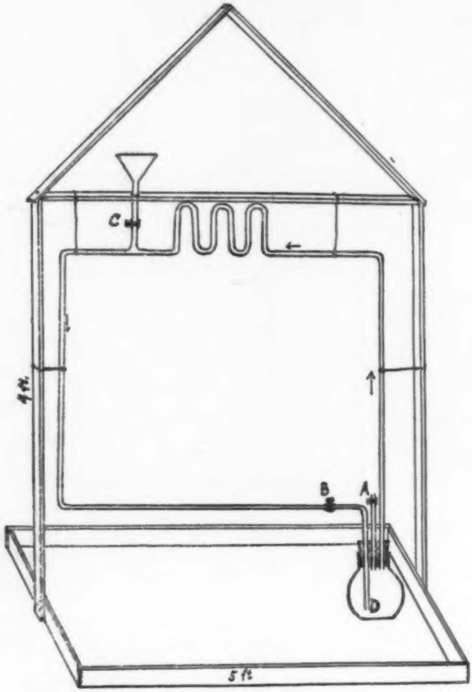
This shows that the flask of cold water is heavier than the flask of warm water.

Experiment III. Model of Hot Water Heating System.

A large wooden frame was made to represent a house. The pipes are of ½ inch glass tubing, connected by rubber tubing. A funnel is used for the expansion tank. For the heater a glass flask with a large mouth is used.

Pinch cocks are placed at A, B and C. The flask is filled with water colored red. To fill the system with water attach a piece of rubber tubing from the faucet to the end of D. Open the faucet slowly. When the water fills the system, close C. Turn off the faucet. Close B. Press the rubber stopper into the mouth of the flask firmly. Fasten it with wire. Now close A. Open B and C. The system is now ready to operate. Heat the flask. The colored water rises in the glass tubing, flowing slowly through the radiator and down the opposite side, back to the flask again. The circulation of the water is shown very clearly and forcibly.

The final step in the development consists of the study of large charts showing house plans for hot water heating.



This arrangement makes possible a continuous revelation of the scientific facts involved. The boy is able to reason out clearly and quickly the phemomena that occurs. The large model is of much greater educational value than the small pieces of apparatus, which leave so much to the imagination.

Free Pamphlets

Lubrication of the Automobile. No. 1—The Engine. No. 2—The Chassis. The Vacuum Oil Company, 61 Broadway, New York City.

Crops That Pay. (Finely illustrated). American Agricultural Chemical Company, 92 State Street, Boston, Mass.

Science Teaching in Secondary Schools. Secondary School Circular, No. 3. Bureau of Education, Washington, D. C.

What is Man?

A man weighing 150 pounds will contain approximately 3,500 cubic feet of gas-oxygen, hydrogen and nitrogen in his constitution, which at eighty cents per thousand cubic feet would be worth $2.80 for illuminating purposes. He also contains all the necessary fats to make a 15-pound candle, and thus, together with his 3,500 cubic feet of gases, he possesses great illuminating possibilities. His system contains 22 pounds and ten ounces of carbon, or enough to make 780 dozen, or 9,360 lead pencils. There are about fifty grains of iron in his blood and the rest of the body would supply enough of this metal to make one spike large enough to hold his weight. A healthy man contains 54 ounces of phosphorous. This deadly poison would make 800,000 matches, or enough poison to kill five hundred persons. This, with two ounces of lime, make the stiff bones and brains. No difference how sour a man looks, he contains about 60 lumps of sugar of the ordinary cubical dimensions, and to make the seasoning complete, there are 20 spoonfuls of salt. If a man were distilled into water, he would make about 38 quarts, or more than half his entire weight. He also contains a great deal of starch, chloride of potash, magnesium, sulphur, and hydrochloric acid in his wonderful human system.

Break the shells of 1000 eggs into a huge pan or basin, and you have the contents to make a man from his toe-nails to the most delicate tissues of his brain. And this is the scientific answer to the question, "What is Man?"—*Exchange.*

Book Reviews

The Teaching of Science, by John F. Woodhull. The Macmillan Company; 249 pp.

For many years Professor Woodhull has been working aggressively to make science in the schools more vital to the boys and girls. In this book we find eighteen of his addresses and papers covering a period of time from 1895 to the present. It makes an admirable contribution to the history of an important transition period of science teaching. It deals for the most part with physical science but general science and project teaching receive considerable attention. You will find this book both interesting and valuable.

The Teaching of Science in the Elementary Schools, by Gilbert H. Trafton. Houghton Mifflin Company; 293 pp. little $1.40.

Five chapters are devoted to the pedagogy of science teaching. These are good. Particularly helpful are the suggestions for correlation. Problem work is discussed but the more difficult projects are not suggested, except indirectly in the chapter on motivation.

The science work is divided into four parts: Biological Science, Agricultural Science, Hygiene and Physical Science. The present trend in education is to get away from special science in the grades and even though this book is for teachers it tends to preserve traditions which will be passed on to the young pupils. Every elementary school teacher ought to read the chapter on the teaching of hygiene. It stimulates one to new endeavor in this much neglected subject. The book closes with a two-chapter detailed outline for science in grades 1-8. Teachers will find this outline very suggestive, and the addition of a few typical lessons fully worked out would be still more helpful.

An Introduction to the Study of Science, by Wayne P. Smith and Edmund G. Jewett. The Macmillan Company; 620 pp. $1.40.

Unlike many general science books this text has little to suggest special science to the pupils. Most of the chapter topics lend themselves to all around science treatment. Transportation is a topic developed to a greater extent than in other books. "Building Materials" is given fifty pages. Other topics are: Weather, Fire and Heat, Refrigeration, Artificial Lighting, Water Supply, Plants in Relation to Man, Insects and Human Health, Micro-organisms, and the Protection of Health. The book is written for the first year of high school and is well adapted to the grade. Many exercises or demonstrations are included. There are summaries and questions for review. The line cuts used tell their story well but we miss the customary half tones.

Personal Hygiene and Home Nursing, a Practical Textbook for Girls and Women for Home and School Use, Louisa C. Lippitt, R. N., University of Wisconsin, illustrated, vii.; 256 pages. Price $1.28. World Book Company.

This book belongs to a series edited by Professor Ritchie. It touches the vital topics in a most vital subject—health. Rules for good health with underlying reasons are clearly stated. Care of infectious and communicable diseases, first aid in accident and sickness—in short, it gives "practical instruction for the conduct of the daily lives" of girls and women for whom the book is written. It is not technical, but a book adapted to the lay-reader as well as to the immature student.

What to Make

Making Storage Battery Cells, p. 917 Pop. Sc. Mo. Dec. 1917.

Constructing a Thermostat to Regulate Furnace Heat, p. 953, Pop. Sc. Mo. Dec. 1917.

A Night Light of Battery Cell and Miniature Lamp, p. 147, Pop. Sc. Mo. Jan. 1918.

Home Made Elec. Lantern for a Dry Battery Cell, p. 149, Pop. Sc. Mo. Jan. 1918.

High Temperature Electric Furnace for the Laboratory, Ev. Eng. Mag. 5: 5-6. Apr. and May, 1918.
Small Storage Battery made with a sponge, Pop. Sc. Mo. 92: 631. Apr. 1918.
Wireless Telephone, Pop. Sc. Mo. 92: 639. Apr. 1918.
Speedometer for Small Battery Motor, El. Exp. 5: 770, Mar. 1918.
Simple 110-Volt Rheostat, El. Exp. 5: 778, Mar. 1918.
Resolving Drum for Developing Roll Filmes, Pop. Mech. 29: 476. Mar. 1918.
A Remagnetizer, Pop. Mech. 29: 477. Mar. 1918.
A Synchronous Motor, made from an Iron Pulley, Ill. R. V. Wilson. El. Exp. 5: 842-843. Apr. 1918.
Toy Locomotive. Pop. Mec. Page 313, Aug. 1918.
Sprayer or Air Brush. Pop. Mec. Page 462, Sept. 1918.
Post Card Protector and Enlarging Camera. Pop. Mec. Page 469, Sept. 1918.
Anemometer. Pop. Mec. Page 473, Sept. 1918.
To Bore Large Holes in Glass. Pop. Mec. Page 616, Oct. 1918.
Hydraulic Postal Scales. Pop. Mec. Page 636, Oct. 1918.
Automatic Candle Extinguisher. Sc. Am. Page 484, Dec. 14, 1918.
Battery Electric Lamp for the Dark Room. Sc. Am. Page 442, Oct. 30, 1918.
A Sensitive Galvanometer. Ev. Eng. Mag. 5: 256, Sept. 1918.
A Test Tube Kipp Generator. Ev. Eng. Mag. 5: 264, Sept. 1918.
Shocking Device for Commercial Current. Pop. Sc. Mo. 92: 948, June, 1918.
Night-bell and Flash-light. Pop. Sc. Mo. 92: 952, June, 1918.
Toy Steamboat. Pop. Sc. Mo. 92: 952, June, 1918.
A Microscope. Pop. Sc. Mo. 93: 301, Aug. 1918.
A Voltmeter. Pop. Sc. Mo. 93: 305, Aug. 1918.

Science Articles in Current Periodicals

AERONAUTICS

Our Navy's Winged Destroyers. (Ill.) A. C. Lescarboura. Sc. Am. 119: 480-481, Dec. 14, 1918.
Getting out Airplane Spruce. (Ill.) Fred W. Vincent. Sc. Am. 119: 438-439, Nov. 30, 1918.
Our Rapidly Expanding Fleet of Dirigible Balloons. (Ill.) Sc. Am. 119: 395, Nov. 16, 1918.
How Aviation Has Done the Impossible. Lit. Dig. 59: 9: 20, Nov. 30, 1918.
Airplane Control. Capt. V. W. Page. Ev. Eng. Mag. 5: 124-5 and 122-4, June and July, 1918.
Airplane Power Plant. Capt. V. W. Page. Ev. Eng. Mag. 5: 219-221 and 270-273, Aug. and Sept. 1918.
Before the Mast in Seaplane and Balloon. (Ill.) Louis R. Freeman. Pop. Mech. 30: 167-173, Aug. 1918.
Destruction From the Sky. (Ill.) Sc. Am. Sup. 86: 356-7, Dec. 7, 1918.

Meteorology in Relation to Aeronautics. W. D. Hines. Sc. Am. Sup. 86 : 351-2 and 386-8, Nov. 23 and 30, 1918.
Map Making from the Sky. (Ill.) Sc. Am. Sup. 86 : 372-3, Dec. 14, 1918.
The Zeppelin Biplane. Sc. Am. Sup. 86 : 316-319 and 334-335, Nov. 16 and 23, 1918.
Instruments for Air Use. Sc. Am. Sup. 86 : 285, Nov. 2, 1918.

ALLOYS
The Ferro-alloys. J. W. Richards. Sc. Am. Sup. 86 : 342-3, Nov. 30, 1918.

ARC-LIGHT
Why Arc-Light Globes Turn Purple. Lit. Dig. 59 : 11 : 24, Dec. 14, 1918.

BRIDGES
The Principal Bridges of the World. Sc. Am. Sup. 86 : 332-3, Nov. 23,1918.
A Bridge that Works like a Kite. Lit. Dig. 59 : 10 : 25, Dec. 7, 1918.

BULLETS
Explosive, Expansive and Perforating Bullets. (Ill.) Claude Pernelle. Sc. Am. Sup. 86 : 332-3, Nov. 23, 1918.

BUTTERFLIES
A Mystery of Insect Courtship. Pop. Opin. 65 : 312, Nov. 1918.

COAL
A New Method of Separating Slate from Coal. (Ill.) H. M. Chance. Sc. Am. Sup. 86 : 348-350, Nov. 30, 1918.

COTTON SEED
Some Coton Seed Products. Ed. C. De Segundo. Sc. Am. Sup. 86 : 382-3, Dec. 14, 1918.

COW
Why I Choose the Guernsey Cow. C. D. Cleveland. Country Life, 34 : 6 : 56-7, Oct. 1918.

DAIRY
War-Time Efficiency Methods Applied to the Dairy Barn. H. V. Stanley. Pop. Mech. 30 : 123-124, July, 1918.

DAYLIGHT SAVING
What Daylight Saving has Accomplished. John A. Ford. Pop. Mech. 30 : 195-196, Aug. 1918.
Geographical Aspect of Daylight Saving Act. Geog. Rev. 6 : 449, Nov. 1918.

ELECTRICITY
Measurement of Resistance. (Ill.) Marion J. Rew. Ev. Eng. Mag. 5 : 164-5, July, 1918.
Electrolysis. R. F. Yates. Ev. Eng. Mag. 5 : 170-1, July, 1918.
Electrolytic Valves; Rectifiers. Gustave Reinberg, Jr. Ev. Eng. Mag. 5 : 106-7, June, 1918.
Wiring for Electric Currents. J. F. Springer. Ev. Eng. Mag. 5 : 108-9, June, 1918.
Electric Bells and Burglar Alarms. (Ill.) A. Semmell. Ev. Eng. Mag. 5 : 122, June, 1918.
Electrical Metering Instruments. Pop. Sc. Mo. 92 : 949, June, 1918.
Principles of Direct Current Dynamos. Pop. Sc. Mo. 93 : 309, Aug. 1918.
Radio Receiver. Pop. Sc. Mo. 93 : 315, Aug. 1918.
Electrically Heated Tools. Lit. Dig. 59 : 13-25, Dec. 28, 1918.

ETCHING
Methods of Glass Etching. (Ill.) W. F. Anderson. Ev. Eng. Mag. 5 : 207, Aug. 1918.

FIRE

Fire as a Weapon. Lit. Dig. 59 : 8 : 24, Nov. 23, 1918.

Forest Fire, The Holocaust in Minnesota. Am. For. 24 : 643-655, Nov. 1918.

FLOWER GARDEN

Insect Pests and Remedies. Dr. F. D. Heald. Gar. Mag. 28 : 144-146, Dec. 1918.

FOOD

The Eulachon—A Delicious Food Fish. Sc. Am. Sup. 86 : 335, Nov. 23, 1918.

Whale Meat Approved by American Public. Sc. Am. 119 : 338, Nov. 16, 1918.

The Food Administration and the Nation's Response. Leonard Hatch, Sc. Am. 119 : 390, Nov. 16, 1918.

The Greenhouse in Food Production. W. C. McCallom. Country Life, 35 : 3 : 56, Jan. 1918.

Food for 1919. F. F. Rockwell. Country Life, 35 : 3 : 58, Jan. 1919.

GAS IN WARFARE

The Defence Against Gas. Pop. Mech. 30 : 562-567, Oct. 1918.

The Canary Birds of War. John W. Harrington. Pop. Sc. Mo. 93 : 258-260, Aug. 1918.

GAS ENGINES

Four-Cycle Versus Two-Cycle Diesel Engines. Sc. Am. Sup. 86 : 307, Nov. 16, 1918.

GYROSCOPE

Single-Wheeled Autocycle. Pop. Mech. 30 : 224, Aug. 1918.

Gyroscopic Unicycle. Pop. Mech. 30 : 335, Sept. 1918.

HEALTH

Nerve Diseases Caused by Success in Life. Cur. Opin. 65 : 380, Dec. 1918.

Pneumonia as a Public Health Problem. Rufus Cole. Sc. Am. Sup. 86 : 346, Nov. 30, 1918.

INFLUENZA

Spanish Influenza—The Disease of Mystery. Sc. Am. 119 : 386, Nov. 16, 1918.

Vaccination Against Influenza. Lit. Dig. 59 : 13 : 25, Dec. 28, 1918.

Expert Medical Advice on Influenza. Lit. Dig. 59 : 13 : 23, Dec. 28, 1918.

How the "Flu" Mask Traps the Germ. Lit. Dig. 59 : 12 : 21, Dec. 21, 1918.

How the Influenza Got In. Lit. Dig. 59 : 9 : 23, Nov. 30, 1918.

The Influenza Epidemic. Sc. Am. Sup. 86 : 343, Nov. 30, 1918.

Is the Influenza a Chinese Plague? Lit. Dig. 59 : 10 : 26, Dec. 7, 1918.

INHERITED TRAITS

The Deadly Female. Lit. Dig. 59 : 7 : 24, Nov. 16, 1918.

JELLY

Cider-apple Jelly. B. Barker. Sc. Am. Sup. 86 : 282-3, Nov. 2, 1918.

LIGHT

Life and Light. Raphael Dubois. Sc. Am. Sup. 86 : 330-8, Nov. 30, 1918.

MAGIC SQUARES

Survival of the Mystical Mathematician. Cur. Opin. 65 : 376-8, Dec. 1918.

MAIL

Mail Service in China. (Ill.) Pop. Mech. 30 : 228-232, Aug. 1918.

MAN
The Origin, Maintenance of Diversity in Man. Marion L. Newbigin. Geog. Rev. 6 : 411-420, Nov. 1918.

MOTORS
The Liberty Motor. Sc. Am. 119 : 455, Dec. 7, 1918.

NAVIGATION
The Rise of Navigation. R. H. Curtiss. Sc. Am. Sup. 86 : 370-1, Dec. 14, 1918.

NITROGEN
Fixing Atmospheric Nitrogen Electrically. (Ill.) R. C. Poulter. Ev. Eng. Mag. 5 : 249-250, Sept. 1918.

ORCHARD
The Concentrated Home Orchard. M. G. Kains. Country Life, 34 : 6 : 58-9, Oct. 1918.

PAINTING
Painting for Protection. L. W. C. Tuthill. Country Life, 34 : 6 : 64, Oct. 1918.

PHOTOGRAPHY
Photographing the Invisible. (Ill.) Wm. S. Salisbury. Ev. Eng. Mag. 5 : 166-7, July, 1918.
An Amateur Photograph Printer. (Ill.) P. H. Fuller. Ev. Eng. Mag. 5 : 208, Aug. 1918.
Fixing Photographic Prints without Hypo. Dudley Kidd. Sc. Am. Sup. 86 : 386-7, Nov. 23, 1918.
The Choice of a Lens. Sc. Am. Sup. 86 : 330, Nov. 23, 1918.

PLANT LIFE
The Energy Theory of Plant Life. Cur. Opin. 65 : 379, Dec. 1918.

POTASH
Extraction of Potash from Kelp. C. A. Higgins. Sc. Am. Sup. 86 : 336, Nov. 23, 1918.

RATS
Rats in the Trenches. Lit. Dig. 59 : 7 : 26, Nov. 16, 1918.
The Invasion of the Trenches by Rats. Sc. Am. Sup. 86 : 259 and 278, Oct. 26, Nov. 2, 1918.

REFRIGERATION
A Home Refrigerating Outfit. (Ill.) Elmer Marr. Ev. Eng. Mag. 5 : 224, Aug. 1918.

RIFLE
The Rifle of the Hour. (Ill.) Ed. E. Crossman. Pop. Mech. 30 : 183-188, Aug. 1918.

ROADS
Will Our Roads Stand Truck Traffic? Lit. Dig. 59 : 3 : 22, Oct. 19, 1918.

RUBBER
Machine Made Rubber. Lit. Dig. 59 : 11 : 25, Dec. 14, 1918.

SALT
Harvesting Salt Lake's Salt. Lit. Dig. 59 : 13 : 24, Dec. 28, 1918.

SOLAR SYSTEM
Early History of the. Sc. Am. Sup. 86 : 359, Dec. 7, 1918.

SPHAGNUM MOSS
Are You Collecting Sphagnum? (Ill.) Geo. E. Nichols. Sc. Am. Sup. 86 : 308-10, Nov. 16, 1918.

STEAM POWER
Operation of Flash Steam Plants. (Ill.) Ev. Eng. Mag. 5 : 251-252.

TANKS
The Secret of the "Baby" Tank. Sc. Am. 119: 431, Nov. 30, 1918.
When the Tanks were Gasses. Lit. Dig. 59: 8: 21, Nov. 23, 1918.
Mechanical Cavalry. (Ill.) Sc. Am. Sup. 86: 312-313, Nov. 16, 1918

TRACTORS
Mechanical Equipment of the Farm. Sc. Am. 119: 482, Dec. 14, 1918.

WATER
Getting New Facts About Water Evaporation. W. T. Stanley. Pop. Mech. 30: 82-84, July, 1918.

WEATHER
Forecasting the Weather Electrically. (Ill.) T. W. Benson. Ev. Eng. Mag. 5: 116-18, June, 1918.
Relation of Weather to Agriculture. Sc. Am. Sup. 86: 354-355, Dec. 7, 1918.

WOOD
The Uses of Wood, Manufacture of Handles. Hu. Maxwell. Am. For. 24: 679-87, Nov. 1918.

X-RAY
The Physical Secret of Reflection. Cur. Opin. 65: 314, Nov. 1918.

Keeping Fit

Good health is at this, of all times, most essential. It is not a matter to be left to the discretion of the individual, with no bearing on the general welfare of the nation. The good health of the individual is an asset of the nation, on which it may draw in its times of need, even more important than its financial resources. A chain is no stronger than its weakest link—a nation no stronger than its weakest component member.

In this connection, the plan of physical exercise as outlined by Mr. Walter Camp, the dean of American football and acknowledged to be one of the great experts on physical fitness, in a recent issue of *Physical Culture* under the title of the "Daily Dozen Set Up," should prove of interest and inestimable benefit to every man unable to devote much time to his physical improvement.

The system is simple—fifteen minutes each day before beginning your work, devoted to a few movements that may be executed by any one not a hopeless cripple. Every important muscle and organ receives just enough work to keep it in good trim, so that you may go to your desk full of vigor, with a spring in your step, a glow over your body and eyes that show physical fitness and full mental vitality.

The plea of "too busy to take the time" is no excuse for failure to keep fit. The Cabinet at Washington, in spite of the onerous duties imposed upon it by the demands of war, still finds time each morning for fifteen minutes to devote to these exercises. If they can find the time, what excuse have you for being unfit? Don't be a slacker—a man unfit when he could become fit is as much a slacker as he who refuses to lend his money to the government. So get busy, get fit, and KEEP FIT.—*Safety News.*

Magazine List

Agricultural Digest. 2 W. 45 St., N. Y. Monthly. 15c a copy, $1.50 a year. Ill. Has suggestions for teachers interested in school gardens and agriculture.

American Forestry. Wahsington, D. C. Monthly, 25c a copy. Splendid pictures for plant and tree study.

Commercial America, Phila. Com'l Museum, Phila., Pa., $2.00 a year. Ill. Commercial production. New Inventions. Will interest Commercial geography and science teachers.

Current Opinion. 65 W. 36 St., N. Y. Monthly, 25c a copy, $4.00 a year. Has a regular department "Science and Discovery" containing articles of popular interest, adapted to pupil or teacher's use.

Country Life, The New. Garden City, N. Y. monthly. 50c a copy, $5.00 a year. Stands at the head of publications dealing with life in the country. Special interest to the general reader and has many articles on gardening and plant study valuable for school use.

Electrical Experimenter. 233 Fulton St., N. Y. Monthly. 15c a copy. $1.50 a year. Ill. Popular articles on electrical subjects which fascinate elementary and high school pupils. Many suggestions for teachers.

Everyday Engineering Magazine. 33 W. 42 St., N. Y. Monthly. 10c a copy, $1.00 a year. Ill. Popular articles on science and mechanics. Much of it is simple enough for elementary pupils.

Garden Magazine. Garden City, N. Y. Monthly. 25c a copy, $2.00 a year. Ill. Helpful to amateur gardeners, teachers and pupils.

General Science Quarterly. Salem, Mass. Quarterly. 35c a copy. $1.25 a year. The only journal published devoted alone to science in the elementary and secondary schools. It tells what schools are doing in science, gives lesson plans, demonstrations, and an extensive bibliography of usable science articles in current periodicals.

Geographical Review, The. Broadway at 156th St., N. Y. 50c a copy, $5.00 a year. Devoted to scientific geography. Original maps and pictures. One department contains condensed items on topics of current interest.

The Guide to Nature. Sound Beach, Conn. Monthly. 10c a copy, $1.00 a year. Ill. Of interest to elementary pupils and teachers of nature study.

Illustrated World. Drexel Ave. and 58th St., Chicago. Monthly. 15c a copy, $2.00 a year. Many short articles on applications of science and mechanics. Popular in style and attractive to elementary and high school pupils.

Journal of the Franklin Institute. Philadelphia, Pa. Monthly. 50c a copy, $5.00 a year. Ill. A technical journal. Contains many articles of value to science teachers.

Journal of Home Economics. 1121 Cathedral St., Baltimore. Monthly. 25c a copy, $2.00 a year. For teachers.

The Literary Digest. 354 Fourth Ave., N. Y. Weekly. 10c a copy, $4.00 a year. Has a department "Science and Invention". Articles are mostly digests from other journals. They are popular in nature and suitable for high school pupils.

Journal of Industrial and Engineering Chemistry. Box 505, Washington, D. C. 60c a copy, $6.00 a year. A technical journal which contains much material which teachers can use. Monthly.

LOCOMOTIVES

Locomotives, Most Powerful Built. Lit. Dig. 59 : 6 : 22, Nov. 9, 1918.

National Geographic Magazine. Washington, D. C. Monthly. 25c a copy, $2.50 a year. Best monthly journal for high grade pictures. Articles are of interest to general reader, pupils and teachers, as well as to geographers.

Nature Study Review. Ithaca, N. Y. Monthly. 15c a copy, $1.00 a year. An illustrated journal for teachers of nature study.

Popular Mechanics Magazine. Chicago. Monthly. 15c a copy, $1.50 a year. Short science items and articles well illustrated. Appeals strongly to elementary pupils. Suggests many construction projects.

Popular Science Monthly. 239 Fourth Ave., N. Y. Monthly. 15c a copy, $1.50 a year. Short science items and articles well illustrated. Appeals strongly to elementary pupils. Suggests construction projects.

School Science and Mathematics. Chicago. Monthly. $2.50 a year. A teacher's journal. Includes many helpful suggestions.

Scientific American. Woolworth Building, N. Y. Weekly. 10c a copy, $4.00 a year. Has longer articles than the other popular science journals. Illustrated and is particularly valuable to high school science pupils and teachers.

Scientific American Supplement. Woolworth Building, N. Y. Weekly. 10c a copy, $5.00 a year. Rather technical, but the majority of articles are usable by science teachers and some of them will do for pupil reference. Illustrated.

Scientific Monthly. Garrison, N. Y. 30c a copy, $3.00 a year. Articles as a rule are more along lines of pure science. Much of value to teachers, articles can be read to advantage by many pupils.

Transactions of the Illuminating Engineering Society. 29 W. 39th St., N. Y. Monthly. 75c a copy, $5.00 a year. Technical. Many articles contain material which can be used in high school classes.